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# The Journal of Bone & Joint Surgery

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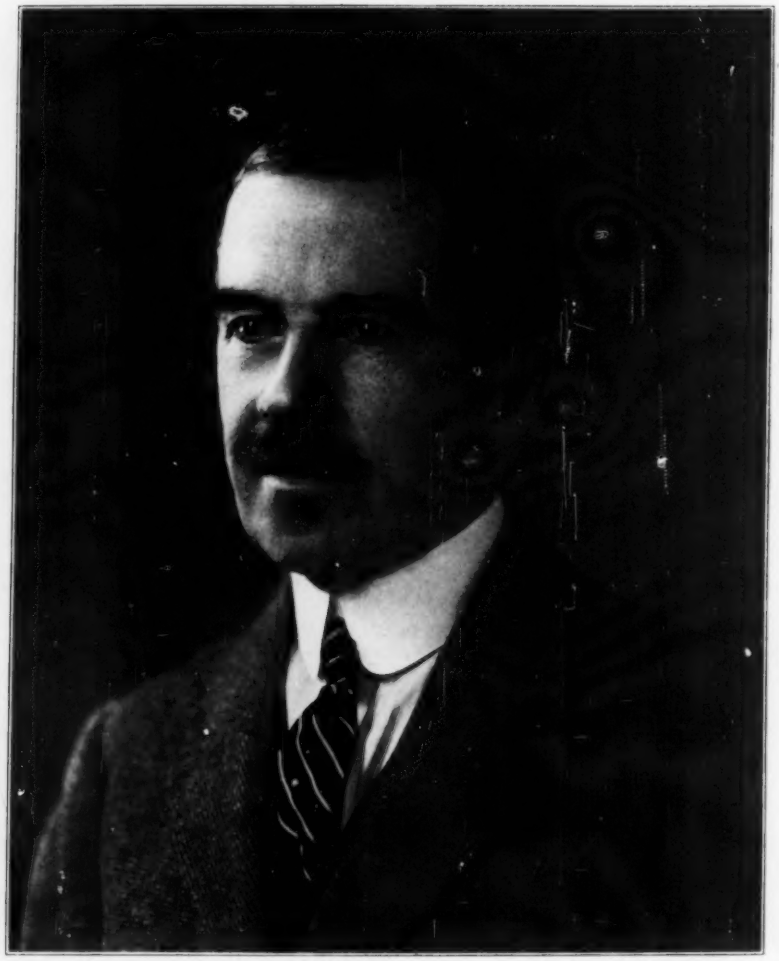


ROBERT W. LOVETT

VOL. VI, NO. 4 OCTOBER, 1924 Old Series: Vol. xxii, No. 4

The Journal of Bone & Joint Surgery

## ROBERT WILLIAMSON LOVETT, A.B., M.D., D.Sc.

Robert Williamson Lovett, A.B., M.D., D.Sc., Charter Member of the American Orthopedic Association, died of nephritis and pericarditis on July 2, 1924, at the residence of Sir Robert Jones in Liverpool. He had planned to spend the summer with his family in the land that, next to his own, he loved best.

Simple, but very impressive, memorial services were held at the Sefton Park Presbyterian Church in Liverpool on July 6th. An international touch was given by the participation of the Honorable Horace Lee Washington, U. S. Consul-General, who entered the pulpit at the beginning and draped the right-hand side with the Stars and Stripes, while Mr. Frederick Watson, son of Dr. John Watson, known to Americans as Ian McLaren, and son-in-law of Sir Robert Jones, draped the left with the Union Jack. The first lesson was read by the Consul-General and the second by Sir Robert Jones. The minister, the Rev. J. S. Macdonald, spoke feelingly of Dr. Lovett's great service to surgery and of "the crooked path made straight" for the crippled child. There was a large attendance of distinguished medical men of Liverpool.

Dr. Lovett's body was brought back to his own country on the Scythia, and the American services were held in Appleton Chapel in the Harvard Yard, July 23rd. The church was filled by his colleagues, patients, and friends, and services were conducted by a classmate, the Rev. Mr. J. W. Suter and by the Rev. S. C. Wellwood, a personal friend.

Born in Beverly, Massachusetts, on November 18, 1859, Dr. Lovett was graduated from Harvard College in 1881 and from the Medical School in 1885. He received his surgical training at the City Hospital in Boston. After a short experience in New York, he settled in Boston. The problems of bone and joint disease in children at once claimed his interest, but as a member of the Surgical Staff at the City Hospital, he practised general surgery for many years. In 1899, he resigned from the City Hospital and his clinic became henceforth the Boston Children's Hospital. In 1912, he became the Chief of its Orthopaedic Department. Teaching appealed to him strongly, and for fifteen years he was on the faculty of the Harvard Medical School. He succeeded Dr. E. H. Bradford as the John Ball and Buckminster Brown Professor of Orthopaedic Surgery, becoming the second incumbent of the chair. This position he held until his death.

During the War, as Major in the Medical Officers Reserve Corps, he was actively engaged in organizing schools of orthopaedic surgery for the training of surgeons, and gave his time and strength unsparingly to the instruction of medical officers. He was elected president of the American Orthopaedic Association in 1897, and was constantly on its important committees. He was president of the Boston Surgical Society from 1920 to 1922. He was Surgeon-in-Chief in the Massachusetts Hospital School for Crippled and Deformed Children, Surgeon-in-Chief to the Peabody Home, Consulting Orthopaedic Surgeon to the New York State Board of Health, Chairman of the Harvard Infantile Paralysis Commission, Surgeon in charge of the Vermont Infantile Paralysis Investigation, Corresponding Member of the British Orthopaedic Association, member of the Societé Internationale de Chirurgie, Fellow of the American College of Surgeons, American Medical Association, Massachusetts Medical Society, etc. His contributions to medical literature were voluminous and significant. His books on Scoliosis and Infantile Paralysis have run through many editions. He was co-author with Dr. E. H. Bradford of the well known Text Book of Orthopaedic Surgery. His crowning work was the preparation with Sir Robert Jones of the comprehensive volume on Orthopaedic Surgery, which is recognized as the latest and most authoritative publication on the subject. His monographs are too numerous to mention, but he never cumbered medical literature.

Such is the veriest outline of Robert Lovett's professional life. It connotes high endeavor and great accomplishment. It is fitting that in addition the American Orthopedic Association should pay its tribute to a personality active and powerful in its councils for thirty-five years. The task is not without difficulty, for he had few confidants. He kept his own

counsel until the appropriate time came to give it away. Then it was often found to be the wisest, and was generally acceptable to the majority. It was always helpful. He possessed a keener foresight, and insight, and farsight than most men. He enjoyed contact with medical politics in its broad and important sense. He often settled knotty questions. Serving on many important local and national boards, he mediated whenever it was possible, but when pushed to the wall fought with courage and great adroitness. If the judgment of his peers prevailed, he was capable of accepting it and of throwing himself into the ranks and striving with them to accomplish the end in view with the weapons they had chosen. He was a powerful executive who was facile and able in organization. He was master in the art of inducing men and women to labor for him and with him, and of compelling their respect by insisting upon the highest standards of work. He was companionable to a degree, with a peculiar charm of manner and an incomparable sense of humor. He was blessed with a capacity for enjoyment in sport, in painting, and in intimate contact with growing things. He was probably most himself with his family and his roses at Lincoln. His patients were accustomed to accept his verdict as the last word. He had many warm friends whose friendship he retained "without capitulation." The personal tribute of Sir Robert Jones, published in the *British Medical Journal*, may well be quoted here. "He represented the highest ideals of our art and brought to bear upon it the rich power of a cultured mind. . . . He had a heart of priceless gold only fully revealed to those he loved."

We had known he was ill and troubled in body for several years, but he was never professionally weary; his mental alertness, the openness of his mind to new ideas, his power of origination never suffered.

"I knew his name would be among the lost
In that great honor roll of men who gave
All that they had and counted not the cost."

R. B. O.

# END RESULTS OF ONE HUNDRED FIFTY-EIGHT CONSECUTIVE AUTOGENOUS BONE GRAFTS FOR NON-UNION IN LONG BONES (A) IN SIMPLE FRACTURES; (B) IN ATROPHIC BONE FOLLOWING WAR WOUNDS AND CHRONIC SUPPURATIVE OSTEITIS (OSTEOMYELITIS).*

BY MAJOR N. T. KIRK, MEDICAL CORPS, U. S. ARMY, F.A.C.S.

*Chief of Orthopaedic Section, Walter Reed General Hospital, Washington, D. C.*

During the four-year period ending December, 1923, there were one hundred fifty-eight (158) bone grafts done on one hundred thirty-five patients in the Orthopaedic Section, Walter Reed General Hospital, for non-union and loss of substance in bones of the extremities. These cases have been divided for this report into: 1. Ununited simple fractures without bone infection, for which there were twenty-nine grafts; and 2. A group of one hundred twenty-nine cases the result of war wounds or other compound fractures followed by severe infection of bone and soft parts. This division is necessary for comparison in the problem encountered, methods employed, and results obtained.

In the first group of non-infected bone, simple fractures and compound fractures without bone infection, there were twenty-nine grafts in twenty-eight patients, twenty-seven of which were successful. One failure was due to a fracture of a "fish tail" graft in the ulna. This graft was too thin to withstand the muscle pull after correction of the old deformity; a second, larger graft of a different type was successful. The second failure occurred in a femur which was re-fractured by a fall after the seventh month. This group includes a transplant of the fibula with its head eleven and a half inches in length, after resection of the upper two-thirds of the humerus with its periosteum for myxosarcoma of the head of the humerus. With this arm, the patient was able to write, carry a scuttle of coal, and build chicken coops. The malignancy recurred, however, and later the shoulder girdle was amputated. There was then actually one failure in this group due to re-fracture by trauma after the seventh month; none were lost by infection or atrophy.

The results in the second group were quite different, and for obvious reasons. There were one hundred twenty-nine grafts, fifty-three of which

* Read at the Annual Meeting of the American Orthopedic Association, May, 1924.

were unsuccessful. The majority of these cases were the result of war wounds, in which at the time of injury severe damage was sustained by the bone as well as its surrounding soft parts. The bone showed marked atrophy and osteoporosis; its osteogenetic power was at a minimum, latent infection was present in the bone and the surrounding scar tissue, and the circulation in both was markedly impaired. Practically all these cases received their fractures during the summer of 1918; some even earlier. The majority occurred in France and had active infection in the bone for from four months to two or more years, causing a destructive osteitis, the usual infecting organism being the hemolytic streptococcus. We have ordinarily referred to this condition of chronic bone infection as osteomyelitis, from which it differs in many respects, but by usage has come to mean the same. Repeated operations for the removal of sequestrum, establishment of drainage, and preparation of the wound for dakinization, further limited the blood supply, increasing scar tissue formation and bone atrophy. Added to this was the atrophy of disuse which further impaired its reparative osteogenetic properties.

As other Army General Hospitals closed, many of the failures there, as well as the non-union cases that were still septic, were gradually transferred here, the easier and more successful cases having been cured and discharged. Others were sent in for treatment by the Veterans' Bureau.

In this group, twenty-six had been grafted elsewhere unsuccessfully; fifteen had been plated or wired, and six had had some type of "stepping" operation. For a two-inch loss of substance in a radius, one surgeon had used a toothbrush handle unsuccessfully. Atrophy was probably most marked in the humerus and next in the tibia, and usually where there was loss of bone substance the bone ends were atrophic, rounded off, or pointed. Eburnation in bone ends with pseudo-arthrosis was seen to a greater extent in the non-infected type, but did occur in the chronic osteomyelitic group, in the tibia and bones of the forearm, without loss of substance, and in the femur and humerus with loss of substance, since there was no second splinting bone to hold the ends apart. This was more often the case in the femur than in the humerus, as bone-end apposition was more frequent.

Loss of substance was the rule in this group, the amount varying from a fraction of an inch to five inches. The whole shaft of the humerus except a couple of inches at each end was destroyed in some eight cases. Several cases with three inches loss of substance in the tibia were grafted successfully. In a case having a five-inch loss of substance, the head of the tibia formed the proximal fragment. This case was grafted once elsewhere and twice here, all three operations being unsuccessful; the first due to

infection and in the latter two operations atrophy and fracture occurred. The leg was eventually amputated.

No attempt was made to graft in any case until it had been healed for at least six months without signs of infection, unless the roentgenogram was negative for sequestrum or evidence of infection in bone, and only after vigorous repeated massage by the Physiotherapy Department. If there was scar tissue present in skin, it was removed and a skin closure first done, at which time any scar tissue in soft parts or about the bone ends was removed. It was found that scar tissue in skin in these cases would invariably break down if at all in proximity to the operative field, and often cause exposure of bone and disaster. If infection followed the scar excision, the graft was not attempted for another six months. If healing was by primum, the graft was done four to six weeks later. Even with this procedure, infection caused twenty-two failures, and nine other cases were severely infected, but union occurred, although the graft was later removed in three. Very severe infection causing failure has been encountered after the original wound had been healed one year and no reaction occurred after a preliminary scar excision. There appears to be no assurance as to when all danger from latent infection is past. In the leg it was sometimes necessary to do two scar excisions and skin plastics before all scar tissue was removed and there was sufficient healthy skin to cover the bone.

TYPES OF GRAFTS

| | *Successful* | *Unsuccessful* | *Unknown* | *Total* |
|---|---|---|---|---|
| Inlay | 78 | 37 | | 115 |
| Intermedullary | 17 | 15 | 1 | 33 |
| Osteoperiosteal | 5 | 2 | | 7 |
| Peg (not intermedullary) | 2 | 0 | | 2 |
| Transplant | 1 | 0 | | 1 |
| | 103 | 54 | 1 | 158 |

The above classification as to type of graft is not accurate. All grafts of the inlay type are grouped under this heading, including true inlays, outlays, "fish tail" type, and "massive" grafts. Most of the grafts were cut with the single Albee saw from the healthy tibia. In 1920 and 1921 the crest of the tibia was used in the humerus, radius, and ulna, but this was later abandoned and the graft was taken from the inner surface. The inlay type of graft was always used in the tibia, usually in the forearm, occasionally in the humerus and femur.

The intermedullary type was found best suited in the atrophic humerus. The cortex was so atrophic that there was practically nothing left but the

medulla, in which there was an increase in fat. The ends of the bone fragments were cut off and the graft introduced, causing a minimum of interference to the blood supply of the bone by way of the periosteum attached to soft parts. Again the graft was driven into the medulla of the upper fragment and inlaid into the bone of the condyles and supra-condylar region. These grafts were reinforced by osteoperiosteal grafts wrapped about them and sutured to the periosteum of the upper and lower fragments.

The osteoperiosteal type was used successfully on two fractured patellas with non-union, one of four years' duration the result of a gunshot wound. The first attempt in this case was unsuccessful, due to the failure of the absorbable suture to maintain fixation of fragments sufficiently long. The third successful case was non-union of nine months, outer end of clavicle one-half inch from the acromio-clavicular articulation. The second failure was the use of this type of graft on a fractured graft.

The size of the graft and its contact with healthy bone is essential to its circulation, life, and proliferation. The general rule I have followed is to cut a graft at least three times the length of the loss of substance to be bridged or of poor bone in which it will be in contact. It is not always possible to get a graft long enough from the healthy tibia to meet these requirements. The average sized graft used in the tibia for non-union in old infected cases was six to eight inches by one-half inch; the smallest in a clean case was four inches by one-half inch; the largest in an old healed osteomyelitic type with three inches loss of substance was ten and a half by three-quarters inches. Grafts of similar proportions were used in other bones. We at first held these grafts in place with kangaroo tendon and chromic catgut through drill holes in the side of the trough. We found that the circulation was so poor that this absorbable material did not absorb but acted as an irritant, causing sinus formation, and was more than once the cause of infection and loss of the graft. I have removed it as long as one year after it was placed in the bone. Its use was discontinued and the grafts made self-retaining without the use of ligatures. This was accomplished by cutting the graft to fit snugly, and a half inch longer than the trough in the inlay type, under-cutting the ends of the cortex on both fragments and sloping the graft ends from above downward so that they could be wedged under the cortex at both ends. The graft is then fitted in position with one end under the cortex, jimmied down to position at the other, and then, using a mallet and an instrument with a sharp point and a shoulder, slid down until the lower end becomes fixed under the cortex. This method is now being used in all grafts.

There were eight cases in this series of bone grafts of the tibia operated upon by an associate of mine in which an entirely different procedure was used; all were successful. He used a small graft cut from the inner surface of the tibia, and after removing all of the endosteum, secured the graft into the fragments without opening the medulla. The graft consisted of periosteum and osteum only, and was placed in contact and made self-retaining in the cortex by cutting a wedge, sloping the graft ends from above downward, and sliding the graft in from the side, the end becoming engaged under the notch that had been cut in the cortical bone. Chances of infection were lessened because there was less bleeding, the medulla not being opened; bone growth was slower than in the inlay type, but occurred. He applied his plaster cast before operation and operated through a window in the plaster.

The tourniquet was not used except in operating upon both bones of the forearm when the bloodless method was employed, but it was removed and all bleeding controlled before the graft was put in position. Hemostasis was difficult in these chronically infected cases, due to oozing from scar tissue, but was as complete as possible before closure.

The skin, except when two incisions were necessary in the forearm, was sutured with silkworm gut, a window was cut in the plaster cast two days after operation, and the wound dressed daily until all stitches were removed, when it was filled in with plaster. This was necessary because of possibilities of infection. When this occurred, stitches were removed and the wound at once dakinized. Nine cases in which infection was severe were saved by this method and many small local skin infections were controlled early, and severe infection avoided. Plaster was removed at the end of three months in the tibia and forearm, a roentgenogram taken and plaster re-applied for another three months in the chronic healed osteomyelitic group. Some required immobilization even longer than this. In the non-infected group, three months immobilization in plaster was usually sufficient. A well-padded body cast was applied at least two days before a humerus was grafted, to insure its proper fitting and setting. The arm piece was put on after the graft was completed. This afforded more comfort to the patient, gave better fixation, and lessened the time on the operating table. In a few cases the arm piece as well as the body cast was applied before the operation and the operation done through a window. This made the procedure much more difficult and was finally abandoned.

The arm was put up in abduction unless the non-union was between the pectoral and deltoid insertions, when it was adducted and brought across the chest, for fear of fracture of the graft from muscle pull.

These casts were not removed until the end of six months in Group 2. The following table shows the bone grafted and the results:

| *Bones* | *Number* | *Successful* | *Unknown* | *More Than One Graft* |
|---|---|---|---|---|
| Clavicle | 1 | 1 | | |
| Humerus | 33 | 18 | 1 | 4 |
| Radius | 16 | 11 | | |
| Ulna | 10 | 9 | | 2 |
| Radius and Ulna | 6 | 4 (7)[1] | | |
| Metacarpus | 1 | 1 | | |
| Femur | 6 | 3 | | |
| Tibia | 60[2] | 50 | | 9 |
| Patella | 2 | 2 | | 1 |
| Metatarsus | 1 | 1 | | |
| | 135 | 103 | 1 | 16 |

[1] Radius only successful in one case—represents seven successful grafts.
[2] One patient had both tibiae fractured.

From this table it will be seen that there were seven patients in whom two bones were involved; six were forearms, the seventh was a patient having an old gunshot wound with F.C.C. and incomplete union in both tibiae, lower third. One tibia had been previously grafted elsewhere and had fractured. Both legs presented adherent scars. The patient begged for a double amputation. This was refused. Four operations were done, one at a time, two scar excisions and two inlay grafts taken from the upper third of the bone being grafted. Both were successful. In addition the patient had bilateral drop foot, due to loss of muscle and tendon. One side was corrected by tendon suture at the time of the bone graft. In the other, the tendons were hopelessly destroyed. The patient is now walking without braces, except a light one to correct the foot drop in the left leg.

There were two cases in which the shoulder joint, head of the humerus, and from two to three inches of the shaft had been shot away, along with the deltoid muscle. In one case the acromion process and outer end of the clavicle was missing. The nerve and blood supply to the arm had not been disturbed. A long adherent scar replaced the deltoid muscle and the long head of the biceps. The arms were useless. After anchoring the remaining shaft of the humerus to the glenoid cavity, at an angle of 90 degrees abduction and in a neutral position as regards flexion and extension, an excellently functioning result was obtained by use of scapular motion in both cases. In the first case, after cleaning out the glenoid cavity, cutting off the end of the humerus, the acromion process was green-sticked, brought down, and a peg from the crest of the tibia was driven through a hole bored

in the acromion, the humeral shaft, and into the glenoid. In the second the glenoid was cleaned out and the humerus cut off and fitted to it. A hole was made one inch deep and three-eighths inch square in the glenoid. A four-inch graft was cut from the tibia, driven into what remained of the medulla of the humerus for three inches. The humerus with the protruding one inch of graft was then fitted to the glenoid with the hole that had been prepared to receive the graft. The humerus was then anchored to the scapula with a piece of silver wire.

One forearm had non-union of both bones with marked deformity, pseudoarthrosis, and severe eburnation of the bone ends, with two large adherent scars. The scars were excised, both ends of the bone were resected, and later, using an osteo-periosteal graft on the radius and an intermedullary peg in the ulna, union occurred. In another case there was malunion in the ulna with bad deformity in two directions, and non-union in the radius, which contained a piece of broken silver wire. The ulnar deformity was corrected by osteotomy and an intermedullary peg, the wire was removed, and a five inch inlay self-retaining graft placed in the radius. Excellent bony union occurred in both, correcting the deformity.

Six times the non-union in the radius was in the lower end, presenting the characteristic radial deviation deformity. This required an osteotomy and shortening of the ulna from an inch to an inch and a half to correct the deformity.

The smallest graft in the series was one and a quarter inches long and three-sixteenths of an inch square, and was used to replace the shaft of the second metacarpal bone. The result was excellent. The tendons had not been destroyed, and after a capsulotomy posteriorly of the metacarpophalangeal joint, the soldier was returned to duty with normal function.

One tibia was grafted with a heterogenous graft, taken from the tibia of another patient of the same blood group, after amputation through the middle third of the leg. This was used because of an old healed chronic osteomyelitis in the opposite tibia, and a sliding graft was impossible on the one having the non-union, there not being sufficient bone. Absorption and infection followed; the osteoclasts appeared to be very active. This may have been due to the fact that the donor of the bone was an Irishman and the recipient an Italian. The Irishman was greatly displeased because the graft failed. All other grafts in the series were autogenous.

One tibia had mal-union with a large unhealed scar three inches in diameter. The lower fragment was displaced outwardly twenty degrees from the long axis of the upper fragment in the position of weakness for weight bearing. The scar was cauterized with the actual cautery, excised, a correcting osteotomy was performed on the tibia, but there was no

attempt at union; some of the bone sequestrated. After another scar excision, the tibia was successfully grafted, the deformity being corrected. Sixteen cases were grafted a second time. Eight were successful, three of these had been unsuccessfully grafted elsewhere, making their third graft. Four were tibias, two ulnas, one a patella, and one a humerus.

Of the eight failures, five had been unsuccessfully grafted elsewhere before, this making their third graft.

The tabulated results of the total series are:

| | *Grafts* | *Successful* | *Per cent. Successful* | *Unknown* | *Failures* | *Patients* |
|---|---|---|---|---|---|---|
| Group 1 (non-infected) | 29 | 27 | 93 | | 2 | 28 |
| Group 2 (chronic osteitis healed) | 129 | 76 | 59 | 1 | 52 | 107 |
| Total | 158 | 103 | 65 | 1 | 54 | 135 |

Only those cases which had definite bone union and had a functional result on discharge were classified as successful. Fortunately, in the military service and likewise in beneficiaries of the Veterans' Bureau, the patient's pay continues and he has no hospital or surgeon's bill to meet. The period of hospitalization, therefore, from a financial standpoint, makes little difference to the patient. These patients were not discharged until there was sufficient bony union in the lower extremity to allow them to walk with the use a brace only to guard against undue stress, and those of the upper extremity were held for a like period. This period was anywhere from six to twenty months after the graft.

Union in Group 2 was never sufficient to allow weight bearing before the sixth month and in some cases not until the ninth and then only with properly fitting braces which were made in our own orthopaedic shop. The war demonstrated that gunshot fractures which united without graft required twice the time to form solid bony union as was the case in peace time fractures, and required splinting or bracing for a like period to prevent refracture or deformity.

The same observation was made in this series of grafts, the period of time required for complete union to occur was from two to three times as long in the chronic osteomyelitis group as in the non-infected group.

Two cases that were originally classified as failures due to infection have recently returned for re-examination and solid bony union was found. It is more than possible that a certain number of cases reported here as failures have united since discharge.

The one case carried as unknown left the hospital in plaster and has not been heard of since.

The cause of failure in 54 cases was:

| | *Group 1* | *Group 2* |
|---|---|---|
| Infection | 0 | 22 |
| Atrophy | 0 | 15 |
| Fracture in plaster before seventh month | 1 | 7 |
| Fracture after seventh month | 1 | 6 |
| Faulty fixation of patella | 0 | 1 |
| Death from shock | 0 | 1 |
| | 2 | 52 |

Infection was the cause of the greatest number of failures and occurred only in the chronic osteitis cases, and we believe was due to latent infection in the bone and soft parts, rather than to accidental infection at the time of operation. The same technique was employed and the same operators operated upon both groups, yet there were no grafts lost from infection in Group 1.

We consider the cause, then, due to latent infection, diminished blood supply in the bone and soft tissues, and the presence of subcutaneous scar tissue and bone atrophy, thereby lowering the vitality of the part. Sequestra not infrequently formed at the end of the fragments along the edge of the trough; apparently the interference with the circulation of the bone in cutting the trough caused its death.

Two sets of instruments were always used when a graft was done, one for the extremity being grafted, and the other for the healthy tibia. Infection was carried into the tibia of the healthy leg once by the use of the same twin saw. Its use was promptly discontinued.

Atrophy was apparently the cause of fifteen failures. This may have been the result of using too small a graft with insufficient bone contact to nourish it, improper fixation, or insufficient blood supply and osteogenetic power in the bone which was grafted to keep the graft viable. The failures actually occurred in those cases showing most marked bone atrophy or loss of substance and in cases with some underlying constitutional disease such as tuberculosis and syphilis, or were in generally poor physical specimens.

Fracture of the graft before the seventh month caused failure in eight cases. Atrophy undoubtedly played a part in these. Other factors were muscle action, poor fixation due to atrophy of the soft parts and shrinkage of the extremity in its cast, and to too much activity, carelessness, and non-co-operation on the part of the patient.

There were ten fractures after the seventh month while wearing braces, some of these as late as the ninth month, all due to trauma. All originally had loss of substance of from one to three inches. All these might readily

be classified as successful. One patient discarded his brace and deliberately re-fractured his graft, as he did not desire his discharge. In three cases the bone reunited without operation, leaving seven failures due to this cause.

Two patients were re-operated upon successfully with inlay grafts along the fractured graft; one unsuccessfully, using an osteoperiosteal graft; one continued to run a systolic blood pressure of from 80 to 100 and was refused further operation. Two left the hospital without further operation; one developed a sinus after three months, and the graft was lost through infection the eighth month, due, we believe, to irritation from the kangaroo tendon ligature.

One failure in a grafted patella occurred, due to absorption of absorbable suture used to hold the fragments in position until consolidation occurred after an osteoperiosteal graft. This case was re-grafted, the fragment being held with silver wire. Union occurred, and the knee flexes to 90 degrees and the patient has sufficient power in the quadriceps to go up and down stairs.

There was one death from surgical shock in a graft of the upper third of the femur.

A blood pressure reading is taken during all grafts every ten to twenty minutes and a careful check kept on the patient's condition. Shock was much more easily produced than is ordinarily the case, due to the long hospitalization with absorption of toxins from chronic infection and repeated operations. When it occurred it was treated with saline intravenously and blood transfusion.

A word about the tibia from which the grafts were taken. As was stated, infection was carried into the healthy tibia once. When the graft is taken from the inner surface, the defect is soon filled in with new bone. I have removed a second graft, eight by one-half inches, six months after the first. The cortical bone did not appear as well calcified, but was thicker than normal. I have removed a third large graft from the same tibia and still found good bone.

When the crest is removed, however, it is not wholly replaced and the patient can easily feel the bone defect with his hand.

All patients were fitted with a tibial caliper when they again became ambulatory about the third week after operation and wore it from eight to ten weeks, depending upon the amount of bone removed. Two fractures occurred in this series, one patient, not wearing his brace, got too close to a motor truck and another fell down a flight of stairs while intoxicated. Both healed without deformity.

## Case Reports

Case No. 1. J. F. S.; Sgt.; Q. M. C.

Patient admitted by transfer with bone tumor head of right humerus, September, 1920. After roentgenogram and consultation with Dr. Bloodgood, a diagnosis of malignancy was made. On his recommendation the following operative procedure was done.

October 16, 1920. Operator: Major Kirk. The upper two-thirds of the humerus with its periosteum was resected. Eleven and a half inches of the fibula with its head

Case No. 1, Fig. 1

Roentgenogram of transplant in position.

and periosteum was transplanted, the lower inch and a half being driven into the medullary canal of the remaining fragment of the humerus. Soft parts were closed. Arm was immobilized on an aeroplane splint.

Patient made good recovery, was able to carry a scuttle of coal, to use this arm in writing, and to use a hammer in constructing a chicken coop. Pathologic section of the tumor showed it to be myxo-sarcoma.

There was a recurrence of the malignancy at the original level of the disease, necessitating a shoulder girdle amputation in August, 1921.

CASE NO. 2. A. H.

Patient sustained G.S.W. left leg, causing F.C.C., and three inches loss of substance in left tibia, followed by chronic osteomyelitis and marked bone atrophy. A large part of the musculature, as well as the skin, was destroyed. Two scar excisions and plastic skin closures were necessary before a graft could be attempted.

CASE NO. 2, FIG. A

Note loss of substance and bone atrophy.

CASE NO. 2, FIG. B

Roentgenogram 3½ months after graft.

Operation, December 2, 1920. Operator: Major Kirk. Bone graft seven inches by one-half inch was taken from the right tibia and inlaid into both fragments and made self-retaining. The graft was covered on three sides at the site of non-union with skin only, and a small sinus developed, which required operation in July, after which the wound healed. Patient was fitted with ischial caliper in December, 1921. He was discharged October, 1922, with good bony union.

CASE NO. 2, FIG. C

August 1, 1922. Roentgenogram shows excellent bony union.

CASE NO. 2, FIG. D
Roentgenogram, May, 1924, showing hypertrophy of graft in tibia.

CASE NO. 3. N. W., Pvt., Inf.

Patient sustained G.S.W. of right forearm, causing F.C.C., non-union both radius and ulna at junction of upper and middle third, followed by chronic osteomyelitis. There were two large adherent scars, marked deformity, and eburnation of both ends of both bones.

Operation, March 5, 1920. Operator: Col. Keller. Scar tissue excised from skin; the eburnated ends of both bones excised and deformity corrected. A Lane plate placed on radius to keep position. This was removed August 4, 1920, when fibrous union was found to be present.

CASE NO. 3, FIG. A
Marked deformity and eburnation of bone ends where the pseudoarthrosis had occurred.

September 23, 1920. Operation: Col. Keller. Osteoperiosteal graft wrapped about the point of non-union in radius and an intermedullary peg placed in the ulna, both taken from the left tibia. Excellent bony union occurred in the radius and fair union in the ulna. The patient was playing ball with this arm when discharged.

CASE NO. 3, FIG. B

After resection of bone ends and removal of plate. Deformity corrected.

CASE NO. 3, FIG. C

March 23, 1921. Excellent bony union and hypertrophy of radius.

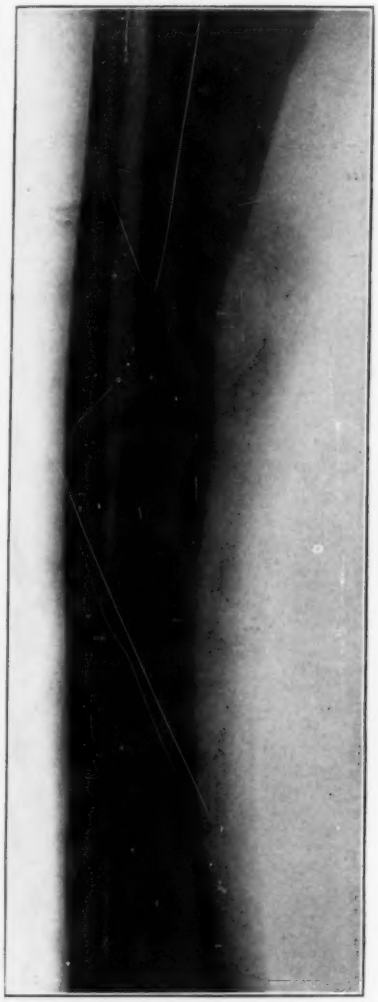
CASE NO. 4. C. B. H.

Patient sustained G.S.W. in right leg, causing F.C.C., and loss of substance in tibia followed by chronic osteomyelitis. Three-fourths of the breadth of the shaft in the middle third of the tibia was lost.

Operation, May 4, 1921. Major Kirk. Bone graft nine inches by one-half inch was taken from the inner surface of the left tibia and inlaid into the normal bone of the upper and lower fragments and outlaid along the six inches of the remaining bone in the middle third. Healing occurred by primum. Patient was kept immobilized in plaster until February, 1922. Fluctuation was at this time found present and a bloody fluid was removed. The fluctuation recurred and the wound had to be incised and dakinized. In July, 1922, a skin suture was done and it healed by primum. The bone was not infected. Patient discharged with good union September 6, 1922.

CASE NO. 4, FIG. A

Roentgenogram December 10, 1921, shows bone being thrown across between graft and old eburnated bone.



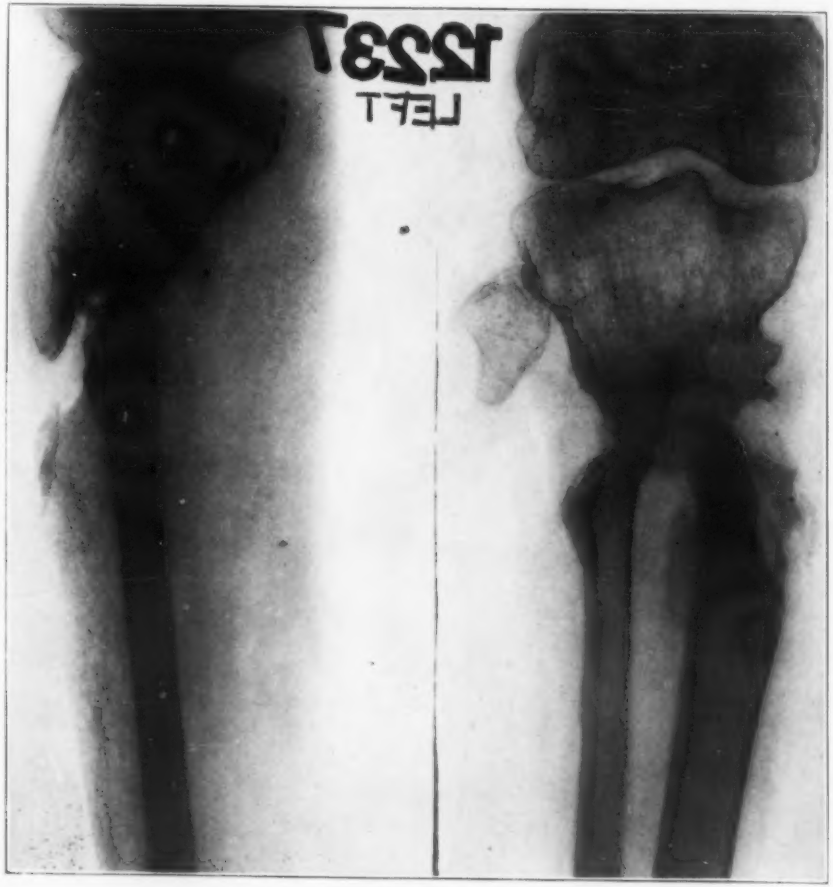
CASE NO. 4, FIG. B

Roentgenogram, July 28, 1922, 14 months after operation. There is excellent bony union.

CASE NO. 5. E. R.

Patient sustained a G.S.W. with F.C.C. and loss of substance, both bones upper fourth of left leg, followed by chronic osteomyelitis. In addition he had a paralysis of the external popliteal nerve. On admission the upper end of both lower fragments of the tibia and fibula were in apposition with the lower end of the head of the tibia. No attempt at union occurred.

Operation, August 31, 1921. Operator: Major Kirk. Bone graft taken from inner surface right tibia was driven into the remaining head of left tibia and inlaid into the upper end of the lower fragment of the tibia. A small slough occurred in the suture




CASE NO. 5, FIG. A
Condition before operation.

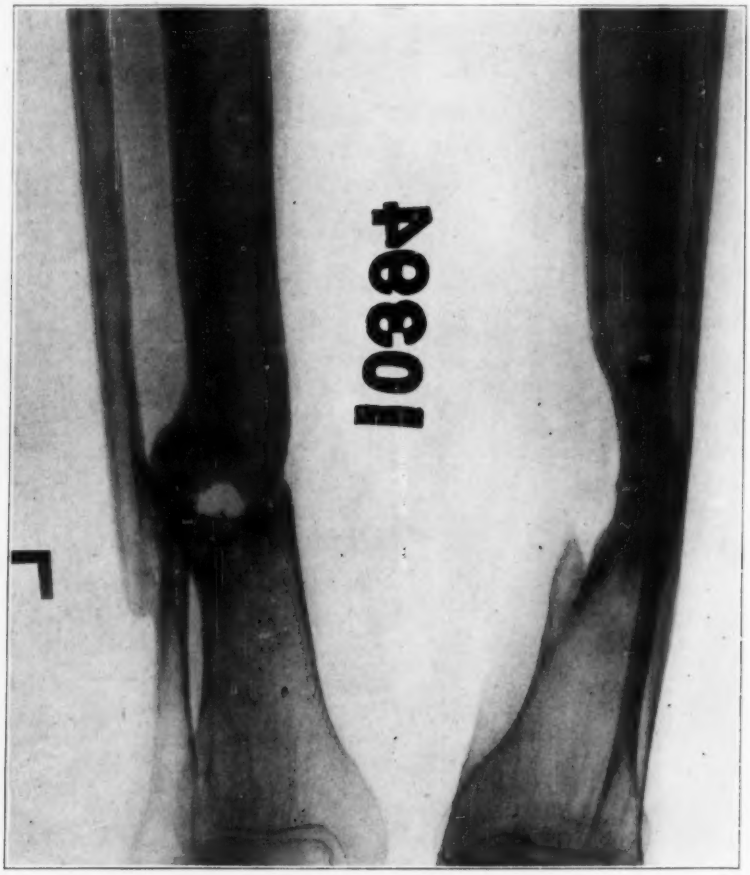
CASE NO. 5, FIG. B
Solid bony union January 17, 1922, five months after graft.

line, which healed. Plaster was removed the seventh month and an ischial caliper substituted. Patient discharged one year after graft with excellent bony union in the tibia as well as union between the head of the tibia and the shaft of the fibula, which occurred only after the tibia was grafted.

CASE NO. 6. W. J. T.

Patient sustained G.S.W. with F.C.C., lower third both tibiae and fibulae, followed by chronic osteomyelitis and loss of muscle substance from extensor muscle group in both legs.

Before admission patient had had a bone graft in right tibia, which had fractured. He requested that both legs be amputated. This was refused. A scar excision was done on each leg, at W.R.G.H.




CASE NO. 6, FIG. A
A.P. view of both tibiae before bone graft.

December 15, 1921. Operator: Major Kirk. A bone graft five inches long was taken from the upper third of the same tibia and inlaid in the lower third alongside old fractured graft and made self-retaining. A tendon suture of the right extensor tendon group was done at the same time.

February 6, 1922. The left tibia was grafted, using a graft 4½ x ½ inches taken from the upper third of the same tibia and made self-retaining.

Healing of skin was delayed in both cases but no infection occurred. Excellent bony union occurred after both grafts.

CASE NO. 6, FIG. B
Right tibia four months after graft.

CASE NO. 6, FIG. C
Left tibia four months after graft.

NOTE. Patient is now walking without any support but a drop foot splint on left leg.

CASE NO. 7. D. A. H.

Patient sustained G.S.W. with F.C.C. and loss of head, neck, and upper two inches of humerus, as well as deltoid muscle, followed by chronic osteomyelitis. The blood and nerve supply to the rest of the arm was not disturbed. The arm hung uselessly by the side.

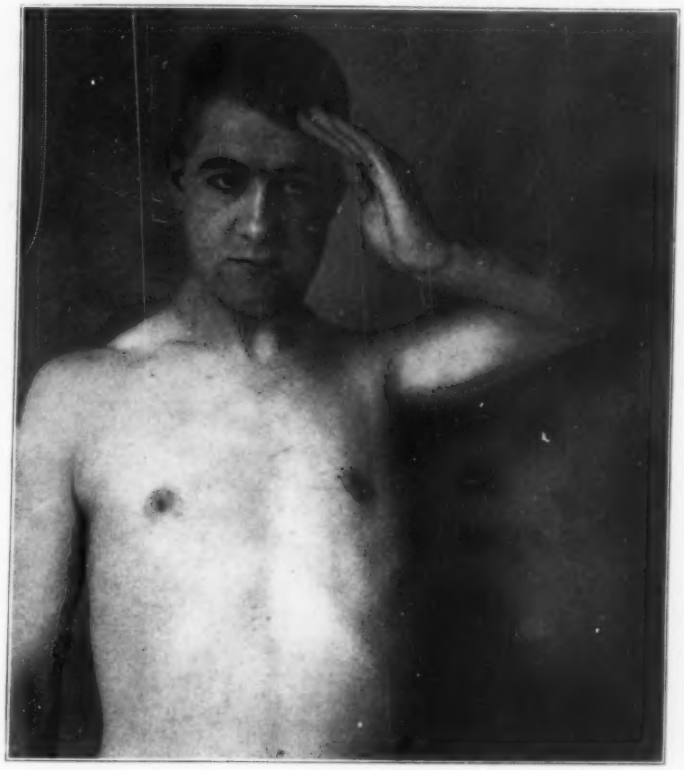
Operation, October 13, 1921. Operator: Major Kirk. Body cast was applied two days before operation. Arthrodesis left shoulder. Glenoid was cleansed out, the acromion process was greensticked and brought down; the end of the humerus cut off and fitted to the glenoid in a position of 90 degrees abduction and neutral as to flexion

CASE NO. 7, FIG. A
Roentgenogram showing loss of bone substance before operation.

and extension. A bone peg from the crest of the tibia was driven through a hole that had been drilled in the acromion process through the upper end of the shaft of the humerus and into the glenoid, fixing the humerus in position. The arm piece of the cast was applied.

The cast was removed at the end of six months and good bony union was found. Arm was kept on an aeroplane splint for four months. Patient discharged with good scapular function.

CASE NO. 7, FIG. B
Good bony union six months after arthrodesis.

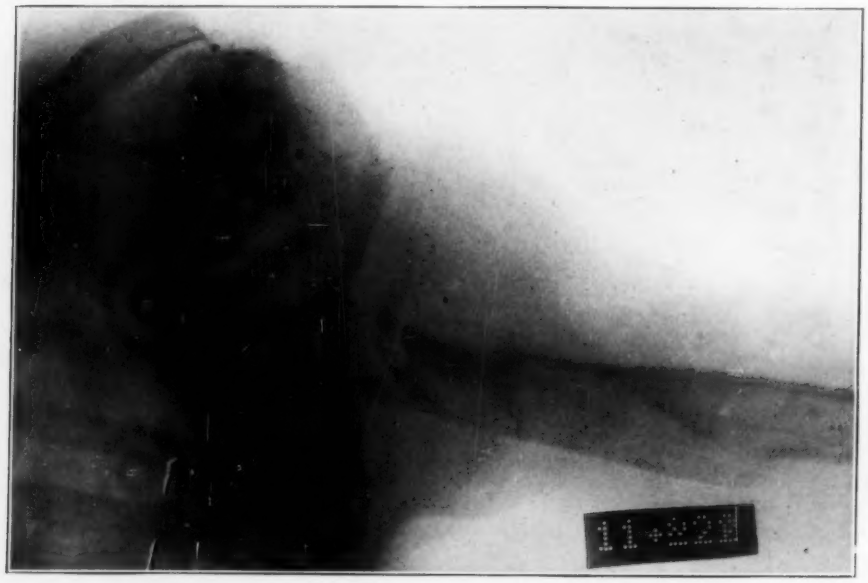


CASE NO. 7, FIG. C
Photograph showing function.

CASE NO. 8. W. H. M.

Patient sustained a G.S.W. with loss of head and upper fourth of shaft of humerus. acromion process, and outer end of clavicle. This was followed by chronic osteomyelitis, The deltoid muscle and long head of the biceps was replaced by scar tissue; the circulation and musculature of the rest of the arm was normal. The arm hung uselessly by the side.

Operation, November 9, 1922. Operator: Major Kirk. Arthrodesis of left shoulder. The glenoid was cleaned out; the upper end of the humerus sawed off. A graft four inches by three and eight-tenths inches was taken from the inner side of left



CASE NO. 8, FIG. A
Roentgenogram before operation showing loss of substance.

tibia and fitted in a hole made in the glenoid one inch deep; removed and driven into the medulla of the humerus. The humerus with the protruding one inch of the graft was then fitted to the glenoid and its cavity. Through a drill hole in the shaft of the humerus and the coracoid process, a silver wire was passed, securing the humerus to the scapula. Patient immobilized in plaster with the humerus at 90 degrees abduction and in a neutral position as regards flexion and extension. Body cast was applied two days before operation and arm piece at time of operation. Five months after arthrodesis, plaster was removed and excellent union was found to be present. Discharged the ninth month with excellent scapular motion.

CASE NO. 8, FIG. B
Union five months after operation.

CASE No. 8, FIG. D

CASE No. 8, FIG. C

Figures C and D. Photographs showing function.

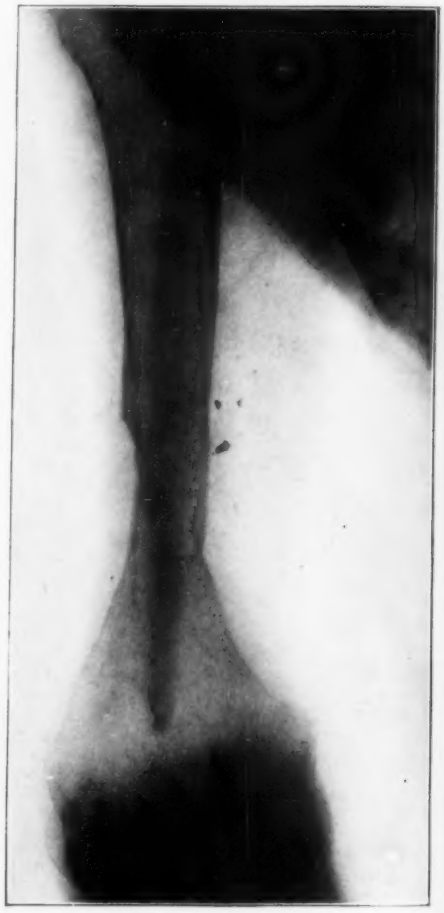
CASE NO. 9. L. E.

Patient sustained G.S.W. in action, causing F.C.C. and loss of substance middle third right humerus, and paralysis of musculo spiral nerve. There was also a chronic osteomyelitis. Before admission humerus was "stepped" and a four inch bone peg introduced into medulla, followed by non-union.

CASE NO. 9, FIG. A
Loss of substance and atrophy present in humerus before graft.

CASE NO. 8, FIG. C
CASE NO. 8, FIG. D
Figures C and D. Photographs showing function.

Operation, April 20, 1922. Operator: Major Kirk. Intermedullary bone graft 6 by ½ inches taken from the right tibia, made self-retaining in medulla. Cortex of fragments had consistency of an egg shell. Cast removed at end of six months, wound having healed by primum. Roentgenogram showed good bony union. Discharged July, 1923.



CASE NO. 9, FIG. B CASE NO. 9, FIG. C

Excellent bony union at end of six months.

CASE NO. 10. O. P.

Patient sustained, along with other injuries, a gunshot wound causing F.C.C. of the right patella. On admission in August, 1922, there was union between the two upper fragments of the patella and separation of some two inches between the upper and lower fragments. Knee flexed to about 45 degrees; muscle power in quadriceps was poor.

Operation, September 1st, 1922. Operator: Major Kirk. Scar tissue was removed from between fragments, which necessitated opening of knee joint; patella was held in position with chromic catgut, using a circular purse string suture and suturing the lateral capsule. An osteoperiosteal graft was placed over and in contact with the anterior bony surface of both fragments.

The co-operation of this patient was poor, to say the least. The absorbable ligatures did not hold and the fragments separated.

CASE NO. 10, FIG. A
Lateral view showing comminuted fracture of patella and separation of fragments.

CASE NO. 10, FIG. B
Union present January, 1924.

Re-operation, December 4, 1922. Operator: Major Kirk. The same procedure was followed as in the first operation, except that the patella was drilled and two pieces of silver wire used for fixation through the drill holes. A new osteoperiosteal graft was placed in contact with the anterior surface of the patella and a third piece of silver wire run through the patella tendon and the insertion of the quadriceps tendon, reinforcing the fixation. Excellent bony union occurred, and when the patient returned in January, 1924, to have a piece of the silver wire, which was broken, removed he had solid bony union, 90 degrees motion, and sufficient power in his quadriceps to go up and down stairs.

CASE NO. 11. A. B. L., Pvt., Inf.

Patient sustained a G.S.W. of right hand causing compound fracture of second, third, and fourth metacarpal bones, followed by mild infection and loss of shaft of second metacarpal July, 1922.

Operation, March 21, 1923. Operator: Major Kirk. A bone graft an inch and a quarter by three-sixteenths of an inch square was driven in a hole made in what remained of the base of the second phalanx and likewise introduced into the proximal end of the remaining shaft and head. Graft was self-retaining. Solid union occurred in two months, with union in the fractured third and metacarpal as well.

July, 1923, a capsulotomy of the posterior capsular ligament of the metacarpophalangeal joint was performed, followed by normal function in the hand, there having been no injury to tendons.

Patient was returned to duty October, 1923.

CASE NO. 11, FIG. A
Roentgenogram showing loss of substance and deformity.

CASE NO. 11, FIG. B
Two months after graft—deformity corrected, with bony union.

CASE NO. 11, FIG. C

CASE NO. 11, FIG. D
Function on completion.

CASE No. 12. J. F., Capt., Inf.

Patient sustained G.S.W. with F.C.C. and loss of substance right tibia lower third, followed by osteomyelitis. Prior to admission, one bone graft had been done which was lost through infection. A large scar was removed here and a plastic closure of skin done.

CASE No. 12, FIG. A
Roentgenogram showing loss of substance.

CASE No. 12, FIG. B
Roentgenogram three months after graft, showing excellent condition of bone.

Operation, December 1st, 1922. Operator: Major Kirk. Bone graft ten and a half by three-fourths inches square taken from left tibia. The lower end was driven into the cancellous bone of the lower fragment. The upper end was inlaid into the upper fragment and the end of the graft fixed under the cortex, making it self-retaining. Patient was allowed to walk beginning the ninth month, wearing an ischial caliper. He was discharged December 2, 1923, with excellent bony union.

CASE NO. 13, FIG. A
Loss of substance.

CASE NO. 13, FIG. B
Roentgenogram three months after graft.

CASE NO. 13. I. K.

Patient sustained G.S.W. causing F.C.C. two and one-half inches loss of substance, lower third left tibia.

Operation, April 15, 1920. Major Mobley. Sliding graft brought down from the upper fragment; bone held in place by kangaroo tendon. Periosteum sutured with catgut. Operation was followed by superficial infection, which healed.

January 13, 1921. Patient fractured graft nine months after operation. Plaster cast applied and later a tibial caliper. Discharged January, 1922, wearing brace; clinically union was present.

CASE NO. 13, FIG. C
Linear fracture ninth month.

CASE NO. 13, FIG. D
Note absorption two months later.

Returned for examination August 12, 1922, when there was solid bony union; more bone proliferation at the site of the fractured graft than anywhere else along the graft which bridged the loss of substance.

CASE NO. 13, FIG. E
Solid bony union, nineteen months after fracture.

CASE NO. 14. J. C. K.

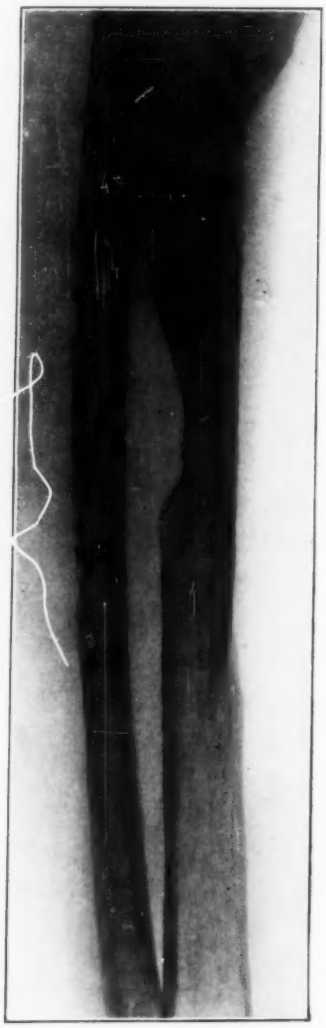
Patient sustained G.S.W. in action, causing F.C.C. and three inches loss of substance upper third left tibia, followed by chronic osteomyelitis.

Operation, August 30, 1921. Operator: Major Kirk. Bone graft, seven inches by one-half inch, taken from inner surface right tibia, inlaid into both fragments and fixed with two kangaroo ligatures. Wound healed by primum. Roentgenogram November 17, 1921, when original plaster was removed and replaced, showing graft in excellent condition. Graft was fractured in plaster some three weeks later. Patient was immobilized in a walking plaster cast or on an ischial caliper until May, 1923. Roentgenogram showed an attempt at union, but a pseudoarthrosis occurred.

May 15, 1923. A second bone graft was done; a graft 7½ by ⅜ inches taken from the right tibia was inlaid into both fragments and outlaid along fractured graft, after freshening graft. The ends of the graft were fixed under cortical bone, making it self-retaining. Roentgenogram in August, 1923, three months after graft, showed union in the old fractured graft, and the new graft in excellent condition. Plaster was removed at this time and ischial caliper fitted. Patient discharged in January, 1924, with excellent bony union.

CASE NO. 14, FIG. A

Roentgenogram November 17, 1921, fracture of first graft during fourth month and loss of substance bridged by graft.



CASE NO. 14, FIG. B

Excellent union in old fracture in original graft and in new graft.

CASE NO. 15. C. W.

Patient sustained a G.S.W. causing F.C.C. of tibia, right, and loss of substance lower third, with a chronic osteomyelitis. The left leg had been amputated through the middle third as the result of a gunshot wound.

Operation, August 30, 1920. Operator: Major Gaul. Bone graft taken from the upper third of the same tibia, consisting of periostum and osteum or cortical bone.

CASE NO. 15, FIG. A

Roentgenogram of graft six weeks after operation.

CASE NO. 15, FIG. B

One year after A, or 13½ months after operation, showing proliferation which had occurred in graft which bridged loss of substance.

only. A trough was made in both fragments, without opening into the medulla, with a notch cut in each end. The graft ends were sloped from above downward and the graft pushed in from the side, the ends fitting snugly in the notches in the cortical bone. The leg was immobilized in plaster before operation and the operation was done through a window in the cast.

Solid bony union occurred, although the proliferation in the graft was slow.

Patient discharged March, 1922.

CASE NO. 16, FIG. A

No attempt at union in old fracture. Note proximity to ankle joint.

CASE NO. 16, FIG. B

Lateral roentgenogram three months after graft.

CASE NO. 16. H. W.

Patient sustained G.S.W. with F.C.C. and loss of substance and chronic osteomyelitis lower third of both bones right leg, one inch and a half above the ankle joint.

Patient had had an unsuccessful "Stepping" operation before admission. Two large scars were excised, one on the outer and the other on the inner surface of the leg before graft.

Operation, May 19, 1922. Operator: Major Kirk. Bone graft four and a half by one-half inches taken from the inner surface of the left tibia. The lower end driven

CASE NO. 16, FIG. C

Roentgenogram eleven months after graft. Outline of graft can barely be distinguished. Note union in fibula.

into a hole centrally placed in the lower fragment of the tibia to the depth of an inch and a quarter, and inlaid into the upper fragment, the end of graft being fixed under the cortex, making it self-retaining.

Excellent bony union occurred in the tibia, and in the fibula as well. Patient discharged wearing brace in May, 1923. He is now wearing no support.

## DISCUSSION ON PAPER OF MAJOR KIRK.

DR. M. S. HENDERSON, Rochester, Minn.: I think we are very fortunate in having this report from Major Kirk. This large series is a careful and honest analysis of results, and is consequently stimulating. I think Major Kirk's results are very good, particularly considering the type of cases he is dealing with. In the total he really got 75 per cent. successes. I take the liberty of juggling his statistics a little. When, considering the number of patients, regardless of the number of operations, he had 75 per cent. good results, I think that is as good as anyone can get in that type of case. The reasons for non-union we do not know. Probably they are local and not general. Severe traumatizing injuries such as the class of cases illustrated are quite a prominent factor in the majority of non-unions. Failures of our operation are due to several causes. I would place first, the lighting up of latent infection, and second, the sloughing of scar tissue with subsequent exposure of the graft. Then there are other instances where the osteogenetic power of the bone seems to be at zero point. Too early weight-bearing and unnecessary strain are factors. There are many points of which I might speak but as this discussion is near the end of a long program I will not take the time.

I want to congratulate Major Kirk and the Walter Reed Hospital on these excellent results.

DR. FRED H. ALBEE, New York City: I agree with Dr. Henderson that Dr. Kirk's presentation is a very carefully prepared and valuable report. There is no more unfavorable case encountered by the surgeon than pseudoarthrosis following compound comminuted infected gunshot fractures. I have been very much interested in Dr. Kirk's work since he was with me at General Hospital No. 3, Colonia, New Jersey. We were interested together there in these cases. I have since followed his cases at Walter Reed Hospital and I have gone there and seen his patients and roentgenograms. I want to compliment him on the very excellent technique he has carried out. I believe the fundamentals of his work are sound in every particular.

There is one observation that I had an opportunity to make late in 1918 that I have not heard mentioned, and that is natural segregation in types of infection in gunshot fractures. In December, 1918, Colonel George E. Brewer came out to General Hospital No. 3 at Colonia, to see the work we were doing there. At this time I had done seventy-three bone grafts for non-union from loss of substances, all of them following gunshot wounds. These were the first cases back from the front. These were the cases that healed promptly, either because of a less persistent infection or because these particular individuals were better able to immunize themselves against whatever infection they may have had. A survey of these cases on that occasion revealed that there were only two of the seventy-three that looked unfavorable because of low grade infection.

Since so many of our men were rushed into the first line in the very beginning of our participation in the World War, there was a large number of casualties in a short space of time. Those cases which healed promptly because of the influences just mentioned were the first to arrive at General Hospital No. 3, and were much more favorable as far as danger of reappearance of infection after plastic operations than those cases arriving later, because of more persistent infection, such as streptococcus hemolyticus, etc., or those who failed to heal their wound quickly because of the inability to immunize and cicatrize favorably.

What may we do to avoid infection? Dr. Henderson mentioned the danger of scar tissue. This danger can be at least partially avoided by a preliminary operation

consisting of taking away the scar tissue and replacing it with a pedicle graft secured elsewhere, or a sliding skin graft obtained locally. Thiersch grafts will not do so well, as they do not restore the soft parts overlying the bone. Extensive areas of scar tissue adherent to the bone in regions of non-union should be replaced by thick pedicle skin grafts. The bone graft inserted at a second operation will then be covered and imbedded in favorable vascular tissue and under good circulatory conditions. The point of using mortise joints to secure bone grafts in place and thus provide for not only the fixation of the graft in place, but the immobilization of the fragments, is important. I use as little kangaroo tendon as possible and when I do, it is of the very smallest size adequate to the occasion. It is not necessary to use large fixation ligatures when accurately fitted inlay or mortise and tenon joints are used. Wolff's law should have a more immediate and complete stimulation on the graft because of this mortise fixation. The transplant should be large in diameter and long enough to give ample contact with vascular tissue whether it be marrow or spongy bone. It should be large enough so as to reduce the possibility of breakage both during and after splintage. The case should be followed post-operatively by careful X-ray study to show when support can be dispensed with.

Major N. T. Kirk, Washington, D. C. (closing the discussion): About plaster and external immobilization, I forgot to state that these chronic cases were immobilized in plaster in which they remained for three months; at which time it was removed and reapplied for another three months. Further immobilization was sometimes necessary. This procedure was used in the tibia. Other cases were immobilized for like periods. A window was cut through the plaster two days following operation and the wound dressed daily. When it had healed, the window was filled in with plaster. If healing did not occur and infection followed, the stitches were removed and the wound dakinized.

As Dr. Albee states, the later cases returned from overseas seemed to have more persistent latent infection than the early ones. This undoubtedly was due to prolonged and severe infection which caused their late return and late operative repair. The hemolytic streptococcus was the infecting organism in practically all cases.

As Dr. Henderson states, the scar tissue should be removed before any graft is done. We always followed this rule and were usually able to make a complete skin closure, using the skin of the extremity itself and did not have to resort to a pedicle flap. One of the cases I showed had to have two scar excisions. He was a syphilitic and an alcoholic, and before his scar excision he had a large area of dermatitis involving the entire scar and a good part of the skin of the leg.

The size of the graft, as Dr. Henderson and Dr. Albee say, is, I think, important. I have always tried to obtain a graft at least three times the length of the loss of substance to be bridged, or of poor bone in which the graft will be in contact.

I am afraid Dr. Albee would not have been able to use an inlay graft in this patella, as there was insufficient bone left in which to inlay a graft.

# SYNOVECTOMY IN CHRONIC INFECTIOUS ARTHRITIS*

(Second Paper)

BY PAUL P. SWETT, M.D., HARTFORD, CONN.

Since my first report on this subject, two years ago, I have been able to add twelve more cases to the list, and my excuse for trespassing upon your attention with a second paper lies in the realization of a sense of the responsibility incurred in proposing or promulgating any extensive surgical procedure. It is the object of this paper to report in summary the further observations which more time and additional cases have provided; to formulate the indications for this procedure or, at least, to suggest the basis upon which to select the cases; and to discuss in greater detail the technique of the operation.

In the selection of the cases it is necessary to reiterate that I have dealt with the infectious type of arthritis alone. Since I have no personal knowledge of the effects of synovectomy in any other type of arthritis it is desirable to define chronic infectious arthritis so that we may labor under none of those misapprehensions resulting from lack of exactness. In these studies there has been a constant effort to follow the Goldthwait classification of the chronic arthritrides and they are divided into the atrophic, the hypertrophic, and the chronic infectious types.

Chronic infectious arthritis may be defined as a chronic polyarticular disease characterized by the usual constitutional features of chronic infection, accompanied by progressive inflammatory changes which begin in the soft tissues and affect the cartilage and bone only secondarily, if at all; it is further characterized by articular swelling, effusion, and thickening, associated with joint spasm, a tendency to flexion deformity, and, in the roentgenogram the presence of capsular thickening and distention, with the absence of primary bone changes.

The first step in the selection of the candidates for synovectomy is the differential diagnosis in order to exclude the atrophic and the hypertrophic groups. Infectious arthritis, as a rule, presents little difficulty in the differentiation from hypertrophic arthritis, but from atrophic arthritis there may be considerable room for question. Certain well defined characteristics

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present themselves and if they are kept in mind constantly much confusion can be avoided. Infectious arthritis is a synovial disease primarily while the atrophic is a bone disease. The roentgenogram shows bone atrophy at an early stage of atrophic arthritis, but in the infectious type bone atrophy shows itself only as the result of disuse and at a later stage. Joint motion is limited by spasm in the infectious type, while in the atrophic it is restricted only by deformity. The roentgenographic appearances usually offer conclusive grounds for the differentiation. In the infectious type, there are found effusion, capsular thickening, and pannus-like exudate, with calcification of the mushed-out edges of cartilage, followed by ankylosis through capsular fibrosis and fusion of the cartilage-denuded bone ends. In the atrophic type we find effusion and atrophy of the bone ends, with punched out areas of decalcification, followed by subluxations and only the partial ankylosis caused by impingement of the displaced bone ends.

The next step consists in the accurate, painstaking, and efficient application of those means of treatment which have been found valuable. These means include the localization and surgical removal of the underlying foci of infection; followed by dietetic management along the lines laid down by Pemberton, together with bacterial vaccines and the promotion of general metabolism by heliotherapy, hydrotherapy, massage, and exercise. Regarding these as the constitutional measures, the local treatment consists in partial rest and comforting applications during the acute stage, followed by slowly increasing active exercises, baking, and massage.

As the result of treatment along these lines many of the cases can be expected to clear up, but there remain a certain few in which the treatment has been delayed or ineffectively or unsuccessfully applied, and it is this group which provides the actual candidates for synovectomy. So far as I know, the only contra-indications in this group exist in those patients suffering from debility or constitutional disease so great as to preclude any sort of extensive surgery; or in patients of advanced age; or with gross deformities of the joints, such as subluxations, severe flexion contraction, and fibrous ankylosis. On the positive side, the most promising candidates are those in whose joints marked effusion and coarse crepitation persist without great loss of joint motion. Examples of this type appear to be the patients who have recovered up to the point of resolution of the inflammatory exudate. That is, the active process has been arrested, but the damage in the synovia has not been repaired and the signs and symptoms persist because of the damaged membrane.

With regard to the technique of the operation, little need be said to a

body of surgeons such as this. In my hands the operation still consists in opening the joint at the site of the greatest effusion and capsular thickening and then with scissors and forceps dissecting out all of the diseased inner layers of the synovia down to what appears to be healthy tissue. Occasionally, it has seemed advisable to approach the knee through a semi-circular incision, transecting the patellar tendon just below the patella and then turning back the upper flap to secure the widest possible visualization of the field. It might be preferable to use the split patellar approach and if there is any advantage to the early resumption of active motion it is better to split the patella than to transect the patellar tendon. I am not certain that early motion is so important, and one of my most successful results was obtained after splitting the patellar tendon. The dissection being finished, the joint is dried and closed in layers without drainage. Postoperative fixation is not required. At the end of two weeks, baking and light massage are ordered. Weight-bearing, with or without crutches, is allowed as soon as pain and spasm permit, and full function is gently encouraged as rapidly as the symptoms warrant. The length of time required for the resumption of use naturally varies widely, depending upon the extent of the disease and the degree of general and local atrophy of muscles, bones, and ligaments.

There were three theoretical considerations which led me to try this operation. Namely: (1), the possibility that the manual removal of the inflammatory exudate and its products might promote the return of joint function; (2), the hope that the removal of the secondary foci of infection from within the joints might aid the patient to overcome the disease by permitting greater concentration of those antibodies which normally form in infectious disease; (3), the idea that early resumption of joint function, with the concomitant increase in general activity, might provide the best stimulus to metabolism and thus cut short the period of metabolic sub oxidation which Pemberton thinks is such a large factor in prolonging chronic joint disease. From among the eight cases in the first series and the twelve in the last series, I can easily pick out illustrations which seem to substantiate all three of these theories, but, of course, such illustrations prove nothing. Moreover, twenty examples are too few to be of statistical importance. The fact remains, however, that twenty such cases closely followed as to end-results and sequelae permit one to draw certain conclusions in a tentative way which may be used for future guidance or until a greater experience either corroborates or abolishes them.

In the entire series of twenty patients the joints treated were one wrist, three elbows, and twenty-six knees, making a total of thirty synovectomies.

In none of these have there been the slightest operative complications, sequelae, or constitutional disturbances, so it is apparent that we may conclude that the operation is well borne and relatively free from surgical hazard. As to the theory that the operation might promote the return of joint function, seventeen out of the twenty cases indicate very clearly that this may be expected, because in these seventeen patients the ultimate result has been a prompt return of comfortable motion without subsequent relapse. Indeed, it has been quite striking to find the operated joints remaining freely movable and painless in two instances where there have been marked exacerbations in the other joints.

As to the second theory that the removal of the diseased joint tissue might act so as to permit the concentration of the patient's resistance, nothing definite can be said. The indications are that any such effect is extremely doubtful, because three patients were not benefited at all and four have had subsequent invasions of previously uninvolved joints. This leaves only two out of seventeen that have not suffered extension of their disease after the synovectomy. In the same way no evidence of value can be adduced to show that the resumption of function in badly damaged joints has had any effect upon the metabolism. However, this theory is so logical and so natural that it offers considerable hope of ultimate confirmation. To the extent that lowered metabolism is a factor in prolonging the disease, improvement may be expected to the degree that improved joint function increases the metabolism.

In conclusion, I believe that synovectomy is an operation that warrants further trial in carefully selected cases of chronic infectious arthritis. It may be expected to promote the restoration of function to those joints in which resolution of the exudate has been delayed. It may, also, prevent the further destruction of the cartilages and the secondary ankylosis which would result from the prolonged presence of large amounts of organized inflammatory exudate. As I see it, this operation is applicable to those joints in chronic infectious arthritis in which there is delayed resolution of the synovial exudate. It should be done before bone and cartilage changes occur, in the hope of preventing such changes. Further, bone and cartilage changes do not contra-indicate synovectomy, but the resultant benefit may be prejudiced by such changes and to a degree in direct proportion to their extent.

## DISCUSSION ON PAPER OF DR. SWETT.

Dr. Ellis W. Jones, Los Angeles, Calif.: My experience with synovectomy has been entirely confined to cases of chronic arthritis of the knee joint. There is,

however, a definite type of low grade infection in which, after even months or years, the pathologic lesion still remains in the knee joint. It is characterized by synovial hypertrophy, bone exudate in the form of marginal osteophytes, various degrees of atrophy of the articular cartilage, hypertrophy of the infrapatellar pad and suprapatellar pouch, and degeneration of the semilunar cartilages. While the knee joint may present the roentgenographic signs suggesting arthritis deformans, yet, clinically, the lesion commonly involves but one joint, and pathologic changes of the soft tissue predominate. Usually the bone proliferation is not extreme, and is manifested only by scattered osteophytes. The changes are not uniform throughout the joint, the terminal stage of joint surfaces articulating with bony and not cartilaginous contact existing only in rare cases. Arrest of the infection seems to occur at any stage. The presence of osteophytes, as seen in the roentgenogram, I have found not to be so serious a prognostic factor as it would seem; and the knee joint, even with a considerable formation of osteophytes, may be made painless and useful by synovectomy.

In other words, I have been accustomed to operate on quiescent joints suffering from multiple mechanical derangements as the result of long standing infection, rather than to operate on joints in which acute or even subacute symptoms exist. Dr. Swett suggests the advantage of attacking certain joints even in the presence of an active arthritis. I have never used synovectomy in this type of case and I am not so certain, therefore, of its advantages.

There is a second type of arthritis in which the bone change may be slight or entirely absent, the synovial hypertrophy extreme, forming pedunculated growths of connective tissue—the so-called "lipoma arborescens," or villous arthritis. Painful villous fingers project themselves between the articular margins, with compression of the synovia and constant trauma to the menisci and articular cartilage. The effect of even minor trauma on such a joint is evident. Total excision of the hypertrophied synovia restores early painless function.

I believe that synovectomy is also indicated in a true osteochondromatosis of the knee joint, characterized by the formation of multiple loose bodies.

Our cases reported were all of long standing. The synovial membrane was dense and thickened, and evidence of trauma was found in almost every joint. In several cases, quite extensive erosion of the articular surfaces of the condyles was present, the articular surface of the tibia being relatively smooth. Adhesions were commonly found between the synovial folds in the lateral cul de sacs of the superior joint. Synovial fringes, fibrillation, and derangement of the menisci, together with hypertrophy of the alar ligaments and retropatellar pad, were almost constant findings. Pathologic reports showed chronic inflammatory tissue. Cultures were negative, and micro-organisms absent in stained specimens. Restoration of painless function occurred in every case.

Although synovectomy in the treatment of chronic conditions of the knee joint has distinct value, it must be definitely recognized that its application is limited and must be largely directed to the relief of a disabling condition only after persistent conservative methods have failed.

# INCIDENCE OF TUBERCULOSIS OF THE SPINE COVERING A TEN YEARS' PERIOD (1913–1922) AT THE CHILDREN'S HOSPITAL OF BOSTON.

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A brief summary covering the incidence of tuberculosis of the spine from 1883 to 1896 has been made by Dr. Augustus Thorndike. Thinking that it would be interesting to make a new statistical study of this disease over a ten-year period from 1913 to 1922, I have revised the well-kept records, and the results which were arrived at are as follows:

During this period there were recorded in the Children's Hospital of Boston 341 cases of Pott's disease, as shown by the following table:

| | | | | | |
|---|---|---|---|---|---|
| 1913 | : | 38 | 1918 | : | 48 |
| 1914 | : | 35 | 1919 | : | 41 |
| 1915 | : | 39 | 1920 | : | 23 |
| 1916 | : | 29 | 1921 | : | 31 |
| 1917 | : | 39 | 1922 | : | 18 |

AGE. According to the following data I find that the age of greatest frequency appears to be during the second, third, and fourth years. Two months, 2; 3 months, 1; 4 months, 1; 8 months, 3; 9 months, 2; 10 months, 1; 12 months, 3; 13 months, 1; 14 months, 2; 15 months, 4; 16 months, 1; 17 months, 2; 18 months, 7; 19 months, 3; 20 months, 2; 21 months, 1; 2 years, 74; 3 years, 72; 4 years, 55; 5 years, 26; 6 years, 18; 7 years, 19; 8 years, 14; 9 years, 14; 10 years, 5; 11 years, 6; 12 years, 1.

Dr. Thorndike[1] found in his writing 120 cases. However, inasmuch as all of his patients were children of two years or less, it will not be possible to make comparison with our results. His youngest patients were: "one was two months old, another one week, and two others were said to have been born so." The data of R. T. Frank and Gunter,[2] from the Hospital for Ruptured and Crippled show that the age of two to four years is the most apt to be affected by this disease. Waterman and Jaeger,[3] in one thousand cases from the same hospital, found 600 between the first and fifth years. Wullstein,[4] in 1585 patients, detected 656 under five years. Valtancoli[5] (Rizzoli Institute) shows that tuberculous spondylitis is more frequent at three, four and five years of age.

LOCATION. All the statistics agree that the dorsal region of the spine is the favorite point of attack. My findings are: 179 cases of dorsal involvement, or 58.3 per cent., 66 in the lumbar region, or 19.3 per cent., 63 dorso-lumbar, or 19 per cent., and 23 cervical, or 6.7 per cent.

| | | | | | |
|---|---|---|---|---|---|
| Cervical region | : | 23 | Dorsal region (Upper part) | : | 36 |
| Dorso-cervical region | : | 9 | Dorsal region (Middle part) | : | 79 |
| Dorsal-lumbar region | : | 63 | Dorsal region (Lower part) | : | 73 |
| Lumbar region | : | 66 | Sacro-lumbar | : | 1 |

Thorndike[1] found 87 in the dorsal region, or 75.6 per cent., and among these 36 located in the middle part, 20 in the lower, and 12 in the upper part. Further he notes 14 lumbars, 11 cervicals, 8 dorsal-lumbars, and 3 cervical-dorsals. Waterman and Jaeger[3] state: Dorsals, 709, or 70.9 per cent., the lower part being most often affected. Valtancoli reports: cervical, 7.8 per cent.; cervicodorsal, 2.8 per cent.; dorsal, 40.8 per cent.; dorso-lumbar, 16.2 per cent.; lumbar, 31 per cent.; lumbo-sacral, 1.2 per cent.; sacral, 0.4 per cent.

SEX. There appears to be no predilection as to sex; both seem equally invaded. Male: 186. Female: 155.

FEEDING. In none of the previous reports which I have read, is the method of feeding mentioned. It is curious that 65.2 per cent. were breast fed. Breast fed, 184; artificial, 98; no report, 59.

VON PIRQUET TEST. This test was found positive in 86.3 per cent. Positive, 184; negative, 29; no report, 128.

TRAUMATIC HISTORY. As an etiologic factor, the history of trauma is a matter of much discussion. My findings are: 41.1 per cent. of the cases had a positive history and 58.9 per cent. a negative history. Valtancoli gives 7.3 per cent.; Waterman and Jaeger, 29.8. Positive, 88; negative, 126; no report, 127.

HISTORY OF TUBERCULOSIS. The involvement of an hereditary factor has always been an important feature in the consideration of any form of tuberculosis. However, from my observation 66.5 per cent. had a negative history and the 33.5 per cent. positive. Valtancoli in his analysis gives 13 per cent. Positive, 92; negative, 183; no report, 66.

COMPLICATIONS. Among the usual complications are paralysis. Seventeen cases of paraplegia were found and two of paralysis of upper extremities. Rickets was present in 20 patients, and 21 had tuberculosis in other joints. Rickets, 20; T.B. in other joints, 21; T.B. Meningitis, 7; T.B. Peritonitis, 1; Infantile Paralysis, 1; General Tuberculosis, 1; Osteomyelitis, 2; Spina bifida, 1; Paraplegia, 17; Paralysis upper extremity, 2.

Thorndike in his list gives 17 cases with paralysis, stating that four of these had complete paralysis. Meyers, in the records of the New York Orthopedic Dispensary, found 17 per cent. with paralysis. Tubby states that this is a very unusual and huge percentage. Muirhead has collected ten definite cases of paraplegia in 133 patients. Dollinger, 41 in 700; Waterman and Jaeger, 41 in one thousand; Valtancoli, 3.9 per cent.

Another important complication is abscess formation. Ninety cases, or 26.3 per cent., were afflicted with it. Ilio-psoas abscesses are oftener seen, and represented 58.9 per cent. of the total. Ilio-psoas abscesses: Left, 26; Right, 17; Double, 10; Cervical, 6; Thoracic, 14; Lumbar, 8; Other regions, 9. Waterman and Jaeger found 158 abscesses, or 15 per cent.; Vulpius, in 1945 patients, detected 476, or 25 per cent.; Muirhead Little, 21 in 133 cases, or 28 per cent. Thorndike gives 33, or 28.6 per cent., and Valtancoli 26.6 per cent.

MORTALITY. The following table shows that the most frequent cause of death is tuberculous meningitis.

| | | | |
|---|---|---|---|
| T.B. Meningitis | : 7 | General Tuberculosis | : 1 |
| T.B. Peritonitis | : 1 | | |

Thorndike found two deaths from tuberculous meningitis, three from general tuberculosis, and one from bronchitis. Valtancoli, in 612 cases, gives a mortality of 16.5 per cent.

TREATMENT. In this paper I will not discuss any of the methods of treatment or their results. It is well known that the system most in practice at the Children's Hospital makes use of the recumbent position with hyperextension on a posterior plaster-shell.

## REFERENCES

1. Trans. Am. Orth. Ass'n, XI.
2. Whitman's Orthopedic Surgery, 1919.
3. Trans. Am. Orth. Ass'n, XI.
4. Whitman's Orthopedic Surgery, 1919.
5. Chir. d. Org. di Mov., p. 127, April, 1921.

[The following two papers by Drs. Whitman and Smith-Petersen were read as part of a symposium at the annual meeting of the American Orthopedic Association, in May of this year. The remaining papers, together with the discussion which followed, will appear in the January number of the Journal.—EDITOR.]

# OBSERVATIONS UPON AN ANATOMIC VARIATION OF THE LUMBO-SACRAL JOINT: ITS DIAGNOSIS AND TREATMENT*

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The condition which I shall describe is one that has hitherto been undistinguished in the mass of cases grouped under the heading of "low back pain," or "chronic backache." It was recognized years ago that certain types of hollow back were particularly prone to backache, but the degree of accuracy of our information on this subject is expressed by the following quotation from Jones and Lovett (p. 312).

"The position of the pelvis in the horizontal plane in the erect position would be of importance in connection with scoliosis and faulty attitude if it could be estimated with any degree of accuracy in the living subject."

This, I believe, it is now possible to do.

The ordinary type of round-shouldered person, the slouchy, asthenic, visceroptotic type of school girl, for instance, stands in the attitude of fatigue. The angle of the pelvis with the horizon may be one of 45 degrees, and the lumbar lordosis and dorsal kyphosis are correspondingly increased.† Both the lordosis and the kyphosis are, however, comparatively gentle curves. On inspecting a lateral roentgenogram of such a patient it will be seen that the lumbo-sacral angle is relatively normal—that is, a line drawn in the plane of the superior surface of the first sacral vertebra makes

* Read at the Annual Meeting of the American Orthopedic Association, May, 1924.

† Since this paper was written an article has appeared by Dr. von Lackum, whose anatomical examinations on thirty cadavers gave an average lumbo-sacral angle of 42.5 degrees. (Jour. A. M. A., Vol. 82, No. 4. The Lumbo-sacral Region; an Anatomic Study and Some Clinical Observations.) This confirms the statement made above as to the average angle as determined by roentgenographic examination.

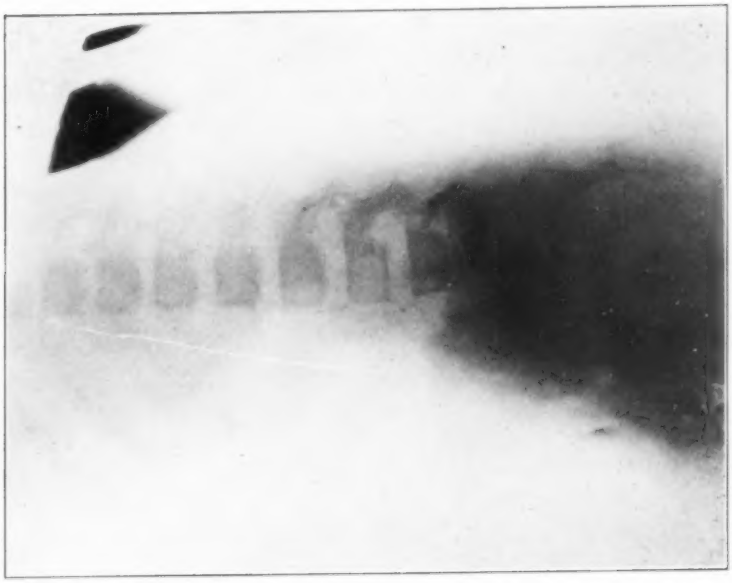

Fig. 2

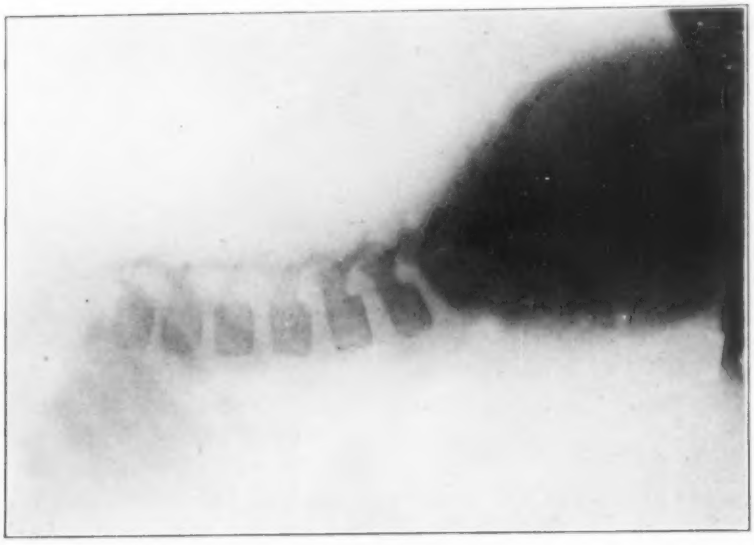

Fig. 1

an angle with the horizon of approximately 45 degrees. Another line, passing through the long axis of the sacrum, forms an angle with the horizon of about 50 degrees.

The small group of cases under consideration presents abnormal lumbar lordosis of a peculiar and distinctive type. In describing the condition I shall read the case histories and examinations, but it is possible first to make a few general descriptive statements.

Chief Complaint. The complaint for which these patients sought relief was pain in the back. The pain is fairly well localized in the region of the lumbo-sacral joint, occasionally running down the front or back of the thighs. It is induced either by indirect violence, such as a fall upon the buttocks or the feet, or by extreme muscular effort, such as an attempt to lift a heavy weight. After having once set in, it is always aggravated by long continued muscular strain. Its character varies from sharp, agonizing pain, of such severity as totally to incapacitate the patient, to a sense of chronic weakness and discomfort. The pain may be lessened, but not entirely relieved, by some form of support. From the first appearance of the symptoms the patient recognizes that he is never completely well—in the sense that between the spasmodic attacks of pain and periods of incapacity he is always conscious that the back is weak. The attacks are not associated with constitutional symptoms, other than those caused by pain. Two of the patients stated that they were actually paralyzed in the lower extremities, but it could not be determined, neither of them having been seen until later, whether the paralysis was actual, or whether they did not wish to move their legs because movement was painful.

Physical Examination. The patients are of no definite physical type. Case 1 would have attracted attention anywhere for his strikingly powerful physique and military bearing. Case 2 was an ordinary adolescent school boy of no worse posture than the average. Case 3 had been a college oarsman. Case 4 was a compactly built housewife. Case 5 had had tuberculosis and looked it. On superficial examination they all had one point in common—that from the side view their buttocks were extremely prominent, so that one would at once accuse them of bad posture. On more careful analysis of the attitude, however, it will be seen that instead of the general curve of exaggerated lordosis there is a sharp increase of the angle between the sacrum and the lumbar spine. The plane of the long axis of the sacrum may be almost parallel with the horizon, and as a consequence of this the lumbar spine is definitely more erect than normal and the dorsal kyphosis is likewise decreased. On running the fingers down the spinous processes one is conscious that in the lumbar region the hollow

FIG. 3

between the muscles is much deepened, and on passing over the tip of the fifth lumbar vertebra one comes upon a sharp obstruction—the spinous process of the first sacral vertebra, as in spondylolisthesis one can feel the margin of the upper surface of the first sacral vertebra. The lumbo-sacral junction is usually tender to pressure, the tenderness being directly in the midline and not over the muscles or sacro-iliac joints. Forward bending is usually limited by slight discomfort, but all motions may be restricted by pain and spasm, depending as to whether or not the case is seen during or soon after an acute attack. The deep hollow at the lumbo-sacral junction is not completely obliterated on forward bending. Movements at the hips are free except that straight leg raising may cause discomfort referred to the lumbo-sacral junction.

Roentgenographic Examination. The examination of the antero-posterior roentgenogram shows nothing definitely abnormal. A good lateral picture makes the condition immediately clear. The long axis of the sacrum lies almost in the horizontal plane, so that the first sacral vertebra affords little if any support to the fifth lumbar. The weight of the vertebral column thus comes directly upon the fifth lumbar vertebra, which is held in place only by ligaments and muscles. One can scarcely imagine an anatomic structure more clearly predisposed to injury. Also the character of the injury to be expected is evident—a forward dislocation of the fifth lumbar upon the first sacral vertebra: in other words—spondylolisthesis.

It will be noticed that while only two of the five roentgenograms show actual forward displacement of the fifth lumbar vertebra, the anatomic structure is otherwise identical, so that it seems not unreasonable to assume that these patients represent the first and second stages along the road leading to complete lumbo-sacral dislocation. I have, therefore, in speaking of these cases adopted the term "prespondylolisthesis."

Surgical Anatomy. This was shown by operation on Case 1. An incision was made in the midline from the spinous process of the second lumbar to that of the third sacral vertebra. The lumbar muscles were unusually thick, so that the difficulty of dissection was much increased. On cutting down upon the sacrum it was found (the patient lying in the prone position) that the superior surface of the sacrum pointed practically directly downward, so that its long axis was nearly vertical. The normal lordosis was lost, the spinous processes of the exposed lumbar vertebrae being in direct horizontal alignment. The angle between the sacrum and the lumbar spine was thus practically a right angle, and the spinous processes of the fourth and fifth lumbar and the first sacral vertebrae were thus vertically contiguous.

Fig. 5

Fig. 4

TREATMENT. The treatment consists obviously of some form of support. It was fortunate that the first patient was an unusually intelligent and energetic person. He was intelligent enough to grasp the mechanism of his condition and energetic enough to refuse a future of continual brace wearing. When the proposition of operation for the purpose of internal

FIG. 6

rather than external splinting was somewhat dubiously advanced it was eagerly accepted. The dissection at operation confirmed the anatomic condition as shown by the roentgenogram. The complete relief from symptoms afforded while wearing the convalescent brace and since discarding it sixteen months ago apparently affords a satisfactory therapeutic test of the correctness of the operative hypothesis.

CONCLUSIONS. I think this condition is worthy of recognition, in that, if it is sought for and found, a number of patients may be relieved of more

or less distressing symptoms. A certain type of backache may be put upon a definite basis. The anatomic predisposition to injury is clear to any one. The ultimate result, complete dislocation, which is certainly to be feared, is recognized as a serious condition. Whether the patient resorts to brace wearing or operation for relief is his own affair, depending on age, sex, health, and particularly upon occupation.

If the condition may be recognized upon routine examination a number of children may be spared blame for bad posture that should not properly attach to them. It is also interesting in connection with industrial surgery. For example, spondylolisthesis is particularly prevalent among the miners in Wales, where it is sometimes referred to as "miner's back." Early recognition of this condition in examining large bodies of men and determining their fitness for various forms of labor might thus be of importance from an economic standpoint.

Case 1. R. C. M. P. Male; 30; oil prospector. December 30, 1922.

*Chief Complaint.* Pain and weakness in the back.

*Present History.* While riding horseback in May, 1918, the horse stumbled, and he experienced a sudden, very severe pain in the small of the back. He was lifted off the horse and carried to his cot, and remained on his back for two weeks, unable to move because of pain. He got up because of the Belleau Wood offensive, during which he forgot about his back. He was then well until 1920, when he was in Mexico. He then experienced a similar attack, coming on from no cause that he can remember, but from which he lay helpless in a Mexican hut for four weeks. The pain passed off gradually. Since then he has had attacks at increasingly frequent intervals, until now they are brought on by coughing, or sometimes simply by turning in bed. He has never had any pain down his legs, but he notices that when his back becomes tired, as it often does toward the end of the day, that the left hip becomes prominent. In 1921 he was given a leather corset, which apparently relieved his symptoms, but was too hot to wear in the tropics, and was discarded for that reason. His general health is otherwise excellent.

*Physical Examination.* The patient is in good condition, exceptionally well-developed and muscular. His back is of normal contour, there is no tenderness over the lumbo-sacral or sacro-iliac joints. Motions in all directions at the lumbo-sacral joint are considerably restrained by muscular spasm and by a feeling of apprehension. Movements of the hips are free and painless. Straight leg raising causes no pain.

*Roentgenogram* of the spine in the antero-posterior direction shows nothing abnormal The lateral view shows a very great increase in the angulation between the spine and the sacrum, so that the lumbo-sacral angle is one of 80 degrees. There is no forward slipping of the fifth lumbar vertebra upon the sacrum, but the peculiar structure would seem to make the lumbo-sacral articulation especially predisposed to injury.

*Operation.* January 17, 1923. The condition found at operation has been described under the heading Surgical Anatomy. The sharpness of the lumbo-sacral angle, the thickness of the muscles, and the depth of the wound made it impossible

to carry out the Hibbs technique in detail. The laminae were scarified as much as possible, and a very thick, semilunar shaped graft taken from the tibia was laid alongside the spinous processes. The processes were then fractured and overlapped as in the Hibbs operation. A number of small bone fragments from the tibia were laid over and around the lumbo-sacral articulation. The ligaments were then closed, holding the graft firmly in position. The wound was closed in the usual manner and a plaster shell applied.

February 3. The plaster shell was replaced by a Knight spinal brace.

March 17. The patient was allowed up.

June 13. He was in good condition, complaining of nothing.

August 20. He apparently has firm ankylosis in the operated area. He has been playing golf and taking ordinary mild exercise with no discomfort. He is to begin to leave off his brace.

May 1, 1924. He reports himself completely well.

Case 2. J. C. Male; 17; schoolboy. July 19, 1923.

*Chief Complaint.* Pain in the back.

*Present Illness.* For the past three or four years, according to the boy's father, he has complained at intervals of pain and of a tired feeling in the back. He has never been particularly active and has always been inclined to lean up against something. According to the patient, he was well until eighteen months ago, when he fell downstairs and landed heavily on his buttocks. He was unable to rise for several moments, and when he did so he had considerable pain in the small of the back, but not down the legs. His back was strapped for two months by the school doctor. He then took exercises in the gymnasium, but was conscious throughout the spring and summer that any sudden jar on the heels was painful and that he instinctively avoided forward bending. During the past year he has been fairly well and able to row, but becomes very easily fatigued and suffers from a continual tired feeling and occasional pain in the small of the back.

*Physical Examination.* The patient is in good condition. He stands fairly erect, but there is noticeable posterior protrusion of the buttocks, the lumbo-sacral angle being about 90 degrees. The normal curves of the spine above the lumbo-sacral joint are thus considerably lessened. There is no lateral curvature. On palpation of the spine there is a very definite hollow at the lumbo-sacral joint, and what is, apparently, the superior surface of the first sacral vertebra can be felt. On forward bending, which is slightly painful, this hollow is almost obliterated. Lateral bending is free and painless. Backward bending causes slight discomfort referred to the lumbo-sacral and sacro-iliac regions. Straight leg raising on both sides causes the same discomfort. There is slight tenderness to pressure over the joint.

*Roentgenogram.* In the antero-posterior direction the roentgenogram is negative. The lateral view shows that the lumbo-sacral angle is practically a right angle. The fifth lumbar vertebra thus derives no support whatever from the first sacral vertebra. There is no actual forward slipping of the fifth lumbar upon the first sacral.

Case 3. W. B. F. Female; 37; housewife. December 28, 1923.

*Chief Complaint.* Pain and weakness in the back.

*Present Illness.* Ever since the patient can remember she has had a curvature of the spine. As far as she knows, however, the curvature has remained stationary. For

an indefinite number of years she has had a backache, the pain being localized, as she expresses it, in the small of the back. It is continuous, dull in character, but does not radiate down the legs and has never come on as the result of a fall or in spasmodic attacks. As a rule it is more severe when the patient is on her feet, but it also occurs after sitting or lying any length of time in one position. While working in a cigar factory it was her habit to place a small hard pillow in the small of her back, which gave her some relief.

*Physical Examination.* The patient is in good condition. The formation of her trunk is somewhat peculiar, in that the buttocks are extremely prominent. There is an exaggeration of the normal lumbo-sacral angle, the spine above the lumbo-sacral junction being rather unusually erect. She presents a very slight rotary lateral curvature of the spine to the left in the dorsal, to the right in the lumbar region. There is a mild degree of rotation evidenced by slight prominence of the ribs on the left side, and a prominence in the right flank due to the rotation of the lumbar vertebrae. Movements of the spine in all directions, but particularly forward bending, are limited by pain and discomfort, which she refers to the lumbo-sacral junction. The limbs are of equal length.

*Roentgenogram* of the entire spine shows a symmetrical double curve as above described, with more rotation than one would have supposed from the external appearance of the trunk. There is a failure of fusion of the posterior arch of the fifth lumbar vertebra, and the entire vertebra is asymmetrical. The lateral view shows that the angle between the lumbar spine and the sacrum is almost a right angle, the direction of the axis of the sacrum being almost horizontal. There is a very slight displacement forward of the fifth lumbar vertebra upon the sacrum.

CASE 4. J. W. S. Male; 30; manufacturer. December 29, 1923.

*Chief Complaint.* Pain in the back.

*Present Illness.* The patient believes he has had a weak back ever since playing football and rowing in college. He states that after a race the pain in the small of the back was almost unendurable, and took two or three days to pass off. During the last five years he has had at increasingly frequent intervals attacks of pain and discomfort brought on as a rule by violence, the violence varying from a fall, tripping over some minor obstacle, to twisting motions of the back, or attempts to lift a heavy object. He states that the pain, when he has forgotten that there was anything the matter with his back and suddenly attempted to lift something out of the way, is immediate and severe, and has lately radiated down the front and back of the right thigh. During the last attack, about a month ago, he was actually in bed for five days, and that at that time his entire trunk deviated toward the left side, and that the pain in the leg was unusually severe. He has been treated during the attacks in a desultory sort of way for rheumatism and lumbago. While the condition is always made worse by any intercurrent disease, he himself has come to recognize that it is a complaint that does not "yield to medicine."

*Physical Examination.* He is in good condition, rather unusually well muscled and developed. General physical examination is negative. On inspection of his back there is noted an unusually deep hollow between the erector spinae muscles in the lumbar region and perfectly definite prominence of the upper border of the sacrum. This hollow is somewhat lessened but is not entirely obliterated on forward bending. The spine above the first sacral vertebra shows a lessening of the lumbar lordosis and

correspondingly of the dorsal kyphosis. The upper border of the first sacral vertebra can be felt definitely projecting beyond the spinous process of the fifth lumbar. Extremes of movement in all directions, particularly forward bending, are restricted by pain and muscular spasm. There is direct tenderness over the spinous process of the fifth lumbar vertebra.

*Roentgenogram* in the antero-posterior direction is negative. The lateral view shows a very great increase in the normal angle of the lumbo-sacral junction and a distinct forward displacement of the fifth lumbar upon the first sacral vertebra.

Case 5. J. T. Male; 32; veteran. January 21, 1924.

*Chief Complaint.* Pain in the back.

*Present Illness.* Dates from three years ago, when, on bending over to lift a heavy object and making a considerable muscular effort, he experienced a sharp, severe pain in the lumbo-sacral region. He did not collapse, and was not confined to bed, and in a few days the pain wore off. He was then entirely well unless he bent over and attempted to lift anything. If he did so the pain invariably returned. The patient says that he has had these attacks at various intervals, depending, naturally, on the type of work he was doing. When lifting heavy cases from the ground up, they would occur every day, while he recognized that he could lift a weight off a table without causing pain. Following the pain the spine is stiff for several days. Hyperextension relieves the pain.

*Physical Examination.* The patient is in fair condition, has apparently lost some weight. On inspection of his back there is evident a rather unusually deep hollow between the lumbar muscles. The spinous process of the fifth lumbar vertebra is situated more deeply than usual and is distinctly tender to pressure. The buttocks are prominent. While casual inspection would seem to show that the lumbar lordosis is exaggerated, closer examination shows that the appearance is due to increase of the lumbo-sacral angle. The lumbar lordosis and dorsal kyphosis are both lessened. Forward bending is somewhat limited by discomfort and voluntary muscular spasm. Movements of the hips, including straight leg raising, are free and painless.

*Roentgenogram* in the antero-posterior direction is negative. The lateral roentgenogram shows the long axis of the sacrum to be almost parallel with the horizon. There is no actual forward displacement of the fifth lumbar vertebra, but it has no bony support whatever.

# ROUTINE EXAMINATION OF LOW BACK CASES WITH PARTICULAR REFERENCE TO DIFFERENTIAL POINTS BETWEEN LUMBO-SACRAL AND SACRO-ILIAC REGIONS*

BY M. N. SMITH-PETERSEN, M. D., BOSTON, MASS.

The examination of back-cases should be systematic, and the examiner should follow a definite line of reasoning, interpreting signs and symptoms. In this brief outline I have tried to put down in condensed form my own line of reasoning and my own interpretation of signs and symptoms. It has enabled me to make a differential diagnosis between lumbo-sacral and sacro-iliac conditions in approximately forty cases, proven to be correct by operation.

HISTORY. As a rule, too little attention is paid to the history. It should be taken in detail, with special reference to the type of trauma and the patient's description of the distribution of the pain. In this brief paper it is impossible to analyze the type of trauma which is apt to cause lumbo-sacral and the type of trauma which is apt to cause sacro-iliac strain. Suffice it to say that the lumbo-sacral and sacro-iliac regions are subjected to leverage from above as well as from below. Leverage transmitted through the ham-strings unilaterally to the pelvis is more apt to cause a sacro-iliac condition; a leverage applied from above, with the spine in a position of flexion, is more apt to affect the lumbo-sacral region.

It is also helpful to find out from the patient what positions are more comfortable. For instance, a lumbo-sacral case can be made comfortable on either side or on his back; a sacro-iliac case as a rule cannot lie for any length of time on the side complained of. These points are merely suggestive and do not hold true in every case.

In regard to the patient's description of the distribution of pain: This, of course, is subjective and cannot be anatomically accurate. It is distinctly helpful, however, when we consider the innervation of the spinal joints and the innervation of the sacro-iliac joints. The spinal joints receive their innervation from the recurrent branch which comes off the spinal nerves, as these emerge from the spinal foramina. Every spinal

* Read at the Annual Meeting of the American Orthopedic Association, May, 1924.

joint then receives branches from two spinal nerves, namely: the one above and the one below.

In the specific case of the lumbo-sacral joint, we find that these receive their innervation from the fifth lumbar and the first sacral. Consequently, lesions affecting the lumbo-sacral junction are apt to give pain projected or referred along the distribution of the fifth lumbar and the first sacral nerves, that is, the dorsum of the foot, first toe, mesial aspect of the sole and heel (fifth lumbar nerve) and antero-lateral and posterior aspects of the lower leg, dorsum of the foot, second, third, fourth and fifth toes, and lateral aspect of the sole of the foot (first sacral nerve). See figs. 1 and 2.

The innervation of the sacro-iliac joint is derived from the following sources:

1. Anteriorly, from the lumbo-sacral cord.
2. Posteriorly, from the first and second sacral nerves.
3. Inferiorly, from the superior gluteal nerve.
4. From the obturator nerve.

There is some question as to the innervation derived from the obturator. The opinions of various anatomists differ on this point. Bardeleben and Morris, however, agree on the first three sources of innervation.

On the basis of the preceding innervation: in sacro-iliac cases we may have pain referred along the fourth and fifth lumbar, and first and second sacral nerves. In other words, we may have pain referred to the posterior aspect of the thigh, as well as to any part of the lower leg. The type of pain most commonly found, however, is the pain referred along the first and second sacral, namely, the posterior aspect of the thigh, antero-lateral and posterior aspects of the lower leg and lateral aspect of the ankle.

Because of the innervation from the superior gluteal nerve we are very apt to have pain referred to the sacro-sciatic notch, extending in the antero-lateral direction along the distribution of the superior gluteal nerve to its termination in the tensor fascia femoris muscle.

Finally, pain over the distribution of the obturator nerve, namely, the inferior mesial aspect of the thigh. I have found pain referred to this area in two cases only: both cases were proven by operation to have a chronic inflammatory process in the sacro-iliac joint.

The above description of peripheral sensory distribution and the diagrams are taken from Tilney and Riley, "Anatomy of the Central Nervous System." These charts agree with the distribution of pain which I have found in a great many of my sacro-iliac cases; they do not agree, however, with the peripheral sensory distribution as given by Head and Seiffer.

EXAMINATION. The examination should be just as careful and

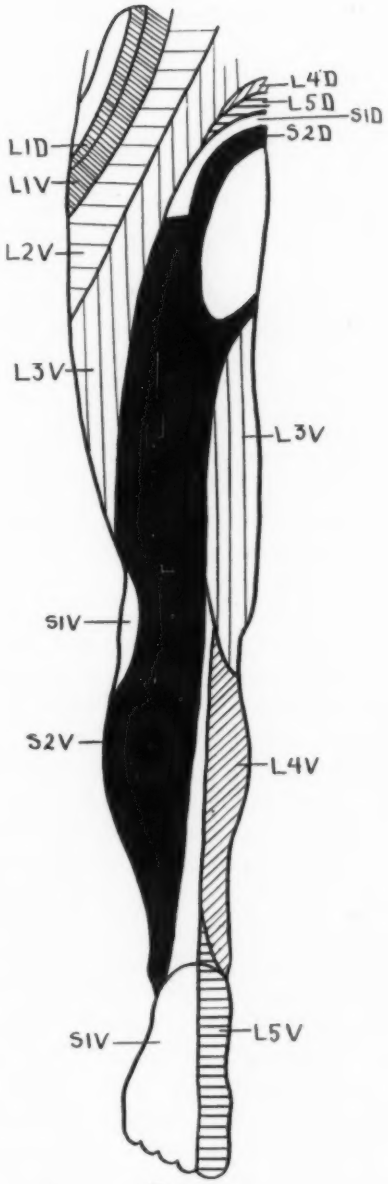


FIG. 1
(From Tilney and Riley)

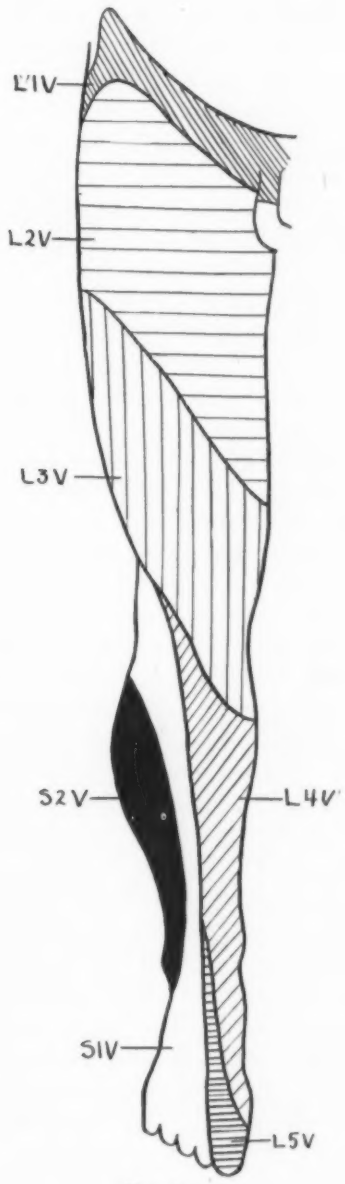


FIG. 2
(From Tilney and Riley)

systematic as a chest examination, and consequently where the internist goes through inspection, palpation, percussion, and auscultation, we should go through our inspection, palpation, motions, and special tests. If we go at our examinations in a hit-or-miss fashion and do not interpret the reactions of the patient to the different tests, we do not have any systematic knowledge at the end of the examination.

I. Inspection. Inspection yields relatively little of a helpful nature in differential diagnosis. There is only one point that I would like to mention. That is, muscle spasm productive of a list. It is usually taught that a list is more commonly away from the side complained of. There are cases, however, where the list is towards the side complained of. I have found this true in cases of sacro-iliac strain, and interpreted it as an attempt on the part of the patient to prevent any leverage on the sacro-iliac ligaments by approximating the two joint surfaces by leaning toward the side affected. Listing away from the side complained of may also occur in sacro-iliac cases, and when it does occur the case is usually an extremely acute one. My interpretation of this sort of a list is that it is an attempt on the part of the patient to eliminate transmission of weight-bearing through the side affected.

II. Palpation. This part of our examination again should be systematic, not hit-or-miss. I have come to adopt a definite route for palpating the important points. This route is shown in the accompanying diagram (fig. 3). The significance of the points marked on the chart is: (1) Posterior superior spine: used simply as a bony landmark. (2) Inferior sacro-iliac ligaments: sensitiveness in this region is in favor of a sacro-iliac condition. (3) Sacrosciatic notch: at this point the superior gluteal nerve curves around as it passes forward between the gluteus medius and the gluteus minimus muscles. Sensitiveness in this region is almost a constant finding in sacro-iliac cases. (4) Sciatic nerve trunk, half way between the ischial tuberosity and the greater trochanter at the level of the gluteal fold. Because of referred pain along this nerve, we sometimes get sensitiveness of the sciatic nerve trunk; but since the sciatic nerve contains branches from the fourth and fifth lumbar as well as the first, second, and third sacral, sensitiveness of the sciatic nerve trunk is not helpful in differential diagnosis between the two regions. (5) Posterior superior spine again: purely as a bony landmark. (6) Mesial to and lateral to the posterior crest of the ilium. In other words, the origin of the ilio-lumbar ligaments and the ilio-costalis muscle, respectively, from the ilium. Sensitiveness in this region is distinctly in favor of a lumbo-sacral condition. (7) The crest of the ilium: purely as a bony landmark and guide to the level of the spinous

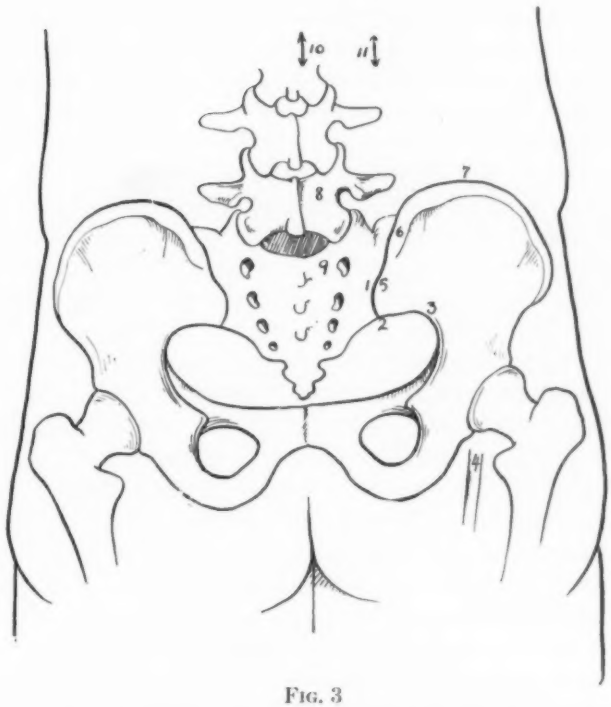


FIG. 3

process of the fourth lumbar. (8) Spinous processes and interspinous ligaments of the fourth and fifth lumbar and first sacral. Sensitiveness in this region again is in favor of a lumbo-sacral condition. (9) Dorsum of the sacrum and articular facets of the fifth lumbar and first sacral. Sensitiveness in this region may occur with sacro-iliac as well as lumbo-sacral conditions because of the nerve supply from the fifth lumbar and first and second sacral nerves; consequently, sensitiveness here is of no particular value in differential diagnosis.

III. MOTIONS. I have found it helpful to divide motions into motions in the three different positions: standing, sitting, and lying, and it is quite interesting in most cases to notice the difference in response on the part of the patient to the same motions performed in different positions. Analyzing this response I have found more helpful than any other part of the examination.

1. MOTIONS STANDING. *a. Flexion* of the spine according to my observations is apt to be somewhat different in lesions affecting the two regions under discussion. In lumbo-sacral conditions, the muscle spasm

is apt to keep the lumbo-sacral region rigid, and forward bending takes place at the hips and in the upper lumbar spine and dorsal regions. In sacro-iliac conditions the patient is apt to bend forward first by flexion of the lumbar spine, then by tilting his pelvis until the hamstrings become taut. At this point, the patient either stops because of pain or flexes his knee on the affected side so as to relax the hamstrings, and then is able to bend over further. *b. Extension.* In lumbo-sacral conditions the patient again keeps his lumbar spine rigid and is apt to bend backward by bending his knees, and there is little or no motion in the lumbo-sacral region. In sacro-iliac conditions, however, there is distinct motion in the lumbar spine, and the pelvis tilts backward, which results in tightening of the ilio-psoas muscle. The tightening of this muscle tends to transmit leverage forward on the ilium, and because of the oblique plane of the sacro-iliac joints, this sort of leverage can only be beneficial in putting the joint surfaces in better apposition. Consequently this motion is performed relatively freely. *c. Lateral flexion or side bending.* In lumbo-sacral cases, there is very little motion at the lumbo-sacral junction; the motion takes place in the dorsal and upper lumbar spine. As to the extent of motion to either side, motion away from the side affected is usually freer than motion toward the side affected. The interpretation of this sign should be made on the same principle as the interpretation of list. In lumbo-sacral cases, as before stated, the list is apt to be away from the side complained of, and consequently, attempt at bending toward the side complained of is against the laws of nature. Lateral flexion in sacro-iliac cases should be divided into two groups. In very acute cases of an inflammatory nature, motion is more limited toward the side affected than away from it; in sacro-iliac strain, however, I think the opposite is true. Again the patient is trying to avoid leverage transmitted through the ilium by muscle pull and to keep the joint surfaces approximated; consequently, he bends more freely toward the side affected than away from it.

2. Motions Sitting. The motion of particular value in this position is flexion. The only difference between flexion sitting and flexion standing is that in flexion sitting the hamstrings are relaxed, and consequently no leverage is transmitted to the pelvis. In sacro-iliac cases, it is quite remarkable to note how freely the patient bends forward from the sitting position, even though flexion standing was markedly limited. In lumbo-sacral cases attempt at flexion of the spine in the sitting position is just as limited as in the standing position.

3. Motions Lying. Passive flexion of the lumbar spine by the examiner flexing the hips and knees is of particular value in differentiating

between lumbo-sacral and sacro-iliac joint conditions. Passive flexion of this sort eliminates to a great extent muscle leverage, and I have come to feel that we get more of a pure joint motion than when we attempt the same tests in the standing position actively. In lumbo-sacral conditions this test, of course, is productive of pain, and the lumbar spine cannot be flexed. In sacro-iliac conditions, however, there is no leverage transmitted to the pelvis, but the pelvis moves as a whole, and consequently the motion is apt to be free. There are cases of acute sacro-iliac conditions, however, where this motion will be productive of pain, but to a much less extent than active flexion in the standing position.

IV. Special Tests. *a. Straight leg raising.* This test, of course, has to be interpreted on the basis of leverage transmitted through the hamstrings to the pelvis, and if carefully performed, this method of examination is decidedly worth while. I do think, however, that a great many examiners do not get the information from this test that they might if they did it carefully and stopped to reason. In doing straight leg raising slowly, one hand should, of course, be under the patient's lower spine. As the hamstrings tighten, leverage is gradually applied to that side of the pelvis. If pain is brought on before the lumbar spine begins to move, I feel that this reaction is definitely in favor of a sacro-iliac condition. If, however, pain does not come on until after the lumbar spine begins to move, this reaction is in favor of either a sacro-iliac or a lumbo-sacral condition, because the sacro-iliac joint is under leverage and the lumbar spine is moving. As we proceed with this test and do straight leg raising on the side opposite the one complained of, in sacro-iliac cases we are able to bring the leg to a higher level without pain. In lumbo-sacral conditions, pain comes on at the same level as it does on the affected side. *b. Compression of the crests and pressure over the pubes;* When these tests are positive they are distinctly in favor of a sacro-iliac condition. The lumbar spine is not under leverage or in motion; the sacro-iliac joints are under leverage. Consequently, if pain is produced it is fairly logical reasoning to say that it is in favor of a sacro-iliac joint condition.

One word as to the method of carrying out "compression of the crests." In order to get efficient leverage on the ilium the patient should lie on the unaffected side; the examiner then puts his forearm on the affected side and leans on it, giving sustained pressure sometimes for as long as half a minute. I have come to feel that if this test is positive the case is apt to be one of acute inflammation or severe strain, but if, on the other hand, it is negative it does not in any way rule out a sacro-iliac condition.

*Rectal Examination.* I have found rectal examination worth while in

inflammatory cases only; since in these cases there is sufficient reaction, swelling, and sensitiveness to be detected by rectal examination. Since the anterior sacro-iliac ligaments cannot be reached by this method of examination, rectal palpation is not worth while in simple cases of strain.

In concluding this outline of examination of low back cases, I want to emphasize the need of careful analysis of every sign and symptom. Since there is no one sign or symptom pathognomonic of a lesion affecting either a lumbo-sacral or sacro-iliac region, we have to depend on the entire picture for our differential diagnosis.

# ROTATORY SUBLUXATION AT THE KNEE.*

BY C. L. LOWMAN, M.D., LOS ANGELES, CALIF.

The decision to offer a paper on this subject when some opportunity presented was formulated about a year ago, after the discussion of a case with one of our leading surgeons.

He brought his nephew to us to find out if anything could be done for a progressive leg deformity which had followed a tubercular arthritis in the knee several years previous.

The patient had been receiving treatment and care by a very competent orthopaedic surgeon until all symptoms of disease had passed. Casts to straighten the leg had been applied, however, without success. The boy gradually began to bear weight in the semiflexed position, and had been doing this for about a year, up to the time he was presented to us.

Inspection of the leg showed a rotatory deviation of the leg on the thigh, with also a moderate angular growth divergency in the tibia, the angulation being outward.

This surgeon, who was also a good roentgenologist, brought several radiographs in which the following findings were obvious: An angular deviation of the leg outward at the knee joint with mal-alignment of the joint constituents, and mal-development of the condyles of the femur and tuberosities of the tibia, the inner condyles of each being enlarged, and the outer of each lessened in depth from above downward, especially marked in the tibia, in which the discrepancy was causing an angulation outward at the junction of shaft and tuberosity. The articular interspace was practically obliterated on the outer side by overlapping condylar shadows, but a little wider than normal on the inner side, and the tibial tubercle was not in the normal sagittal plane. A lateral view showed that the outer tuberosity of the tibia overlapped the shadow of the inner posteriorly, and the head of the fibula, instead of lying in line with the tibial shadow, appeared too far posterior.

Clinically, the mortise of the ankle joint allowed motion in an axis about forty-five or fifty degrees outward from the normal, and efforts at motion at the knee gave a very free action from one hundred and fifty

*Read at the Annual Meeting of the American Orthopedic Association, May, 1924.

degrees of extension back to sixty degrees of flexion. A very decided bony block limited further extension, and a position of confirmed knock knee was maintained.

The surgeon, when told that it was a very common type of knee deformity, stated he had never seen or heard it described. Although our inquiry has so far failed to discover a description of the condition, it is probably a well-known deviation to members of an orthopaedic group, and because of the frequency of its occurrence, may have had some of the technical peculiarities of its incidence overlooked or confused with simple contracture of hamstrings, with flexion deformity of the knee.

The chief reason for bringing it to your attention is to emphasize the causative factors which are important in teaching orthopaedic technicians and physiotherapists. In ordinary clinical teaching experience, I have rarely found a post graduate physical director, physician, or student who can name the rotators of the leg. The knowledge of the function of the popliteus and biceps as inner and outer rotators of the leg when flexed on the thigh is rarely brought to their attention as a matter of practical value.

It may be well to recall that in the normal movement of the knee joint, there occurs just before complete extension a slight inward rotation on a long axis of the outer femoral condyle. In flexion at about one hundred and fifty degrees the structures become looser and allow rotatory movement of about thirty-six degrees (Morris: Joints, p. 375). In fact, according to some authorities (Dever's Surgical Anatomy, p. 714) all the knee joint ligaments are relaxed during extreme flexion.

As so many factors in considering fractures and dislocations of patella and other knee derangements and their treatment involve an understanding of this rotatory phenomenon in this joint, it is important to bear these facts in mind when dealing with any condition disturbing its function.

Inward rotation is checked by the crucial ligaments (Davis' Surgical Anatomy, p. 537) and outward rotation, not being checked as much, may have a much increased range when there is lessening of tone in joint structures with consequent relaxation and when the powerful outward rotator acts.

There seems to be some difference of opinion among authorities in regard to the question of function of the crucials. Dever states that inward rotation is checked by anterior crucial, and external rotation by the posterior crucial. On the other hand, Surls and Osgood state in an article on internal knee derangements that both crucials limit internal rotation and that the crucials are not involved in external rotation in any way. This seems to be in agreement with Davis, and also with Gray (p. 345),

that the crucials uncross during external rotation and that the latter movement is checked by the lateral ligaments, especially the internal.

The quite frequent occurrence of pathologic degrees of external rotation, as against the infrequency of such a condition in the internal position, is also added evidence that there is insufficient check against external rotation.

The cause of this deviation may be any one or several of the usual causes of deformity at any joint, but particularly the unbalanced action between these rotators of the flexed knee, either from definite overaction on the part of the biceps from, for instance, spasm in guarding a flexed or partly flexed knee, as in the case referred to above, or as a passive attitudinal deformity in which the external rotator has shortened with insufficient opposition on the part of the internal rotator.

In discussing the production of torsion in the tibia in a previous article[1] ("Rotation Deformities") photographs were shown of such a position, one especially common in poliomyelitis cases. We have also noted the same thing in a case of recurrent patellar dislocation.

Upon reviewing the literature regarding this condition, I found in 1895 that Dr. Goldthwait, in reporting a case of patella dislocation, mentions that "the attachment of the patellar tendon was so far out on the tibia that the patella would not stay in place even after fascial bands of the external capsule were severed," so he shifted the insertion inward. Dr. Whitman, in discussing this paper, brought out the fact that "in confirmed knock knee there was a rotation of the tibia outward."

Weight-bearing on a semiflexed knee requires more marked contraction of all thigh muscles than occurs when the knee can be carried back to full extension, and the tendency for an inward thrust of the knee over an everted foot adds a very marked element in developing the progressive aspects of the condition by the continual stretching of the internal lateral ligaments, as well as favoring the shorter pull of the biceps.

At least eighty per cent. of all people in this country have some degree of foot deviation, chiefly inward, and as was pointed out many years ago,[2] the leg as a whole tends to rotate inward as the forefoot everts, and the os calcis pronates. There is, then, a very common increase of strain on the inner knee structures, lateral ligaments, and crucials, and when a person has to step down from a high leg to one shortened by flexion, the weight thrust is severe, forcing the thigh inward as the lower leg (through the everted foot) receives an outward rotatory thrust. This thrust gradually stretches the internal ligament, thus relaxing it and allowing external rotation to take place more readily and to a greater amount than normal.

The correction of this deformity may be accomplished in some cases by recurrent casts, and in severe cases, a tenoplasty and fasciotomy may be required before it can be controlled.

The failure to recognize the cause of the mechanical blocking, namely, the impingement of the anterior rim of the outer tibial tuberosity on the convexity of the corresponding femoral condyle, undoubtedly has led to much traumatism in the hands of the untrained and unskilled, in efforts to straighten such legs. This becomes increasingly true as the flexed knee deformity becomes older, because of the change in shape of both femoral condyles and tibial tuberosities, the former becoming more elliptical when unopposed by pressure from the tibia, and the latter sloping downward toward the back. This not only makes reduction difficult or impossible, but also renders it difficult to maintain correction if it is accomplished,—a fact pointed out some years ago by Steele in reviewing the English literature relative to knee excision.

Simple tenotomy of the hamstrings and manipulative straightening may not accomplish the correction unless the tibial tuberosity can be forced forward, which can be done sometimes if the posterior ligaments are lax enough. A full length leg cast should be applied, with very heavy felt padding covering the femoral condyles, and with a long oval opening, large enough to admit the patella, and extending two inches above, in order that the fulcral pressure may not injure the joint linings of the superior aspect of the joint; then a second heavy pad back of the calf, especially covering the head of fibula. The cast when dry is sawn open posteriorly in such fashion that this hinge is so excentric in action that the lower segment will give a forward thrust against the calf.

The wedging goes on as long as results are being attained without pain. Then a new cast is applied, allowed to dry, and wedged on the outside in order to stretch the shortened external lateral ligaments and to gap the external joint space, and thus unlock the impingement within the joint, the amount accomplished being observed by radiographs.

The procedure is then followed by increasing the opening enough postero-internally to allow posterior wedging. The cut in the cast now runs from a point above the joint line in front to below the joint behind. Thus, because of the different radius action, there is a forward thrust on the leg, just what frequently occurs in an ill-fitting brace when the joint at the knee is too high and too far forward, in which case there is undue pressure on the calf.

In severe cases, as in that mentioned in the first part of this article, with marked tightening of structures behind the joint, operation is advisable

through external lateral longitudinal incision about three inches long, the biceps being exposed and lengthened by the sliding method. After section of the tendon, and while the knee is being extended, all fascicular bands are severed cautiously as far back as the popliteal vessels, care being exercised to expose and protect the external popliteal nerve lying under the biceps.

In repair of the tendon, it should be sutured loose enough so that there will be approximately normal tension when the leg is fully extended. No effort is made to get complete correction at this time, extending the knee only to a safe point. Lateral wedging is resorted to as soon as the lateral incision is in satisfactory condition, and care should be taken at the time of operation in padding heavily and in such fashion as to protect the line of incision and the head of the fibula, in order to stand the pressure incident to correction.

In a paralytic case in which there is a weakened or inactive quadriceps, it is entirely feasible to transplant the biceps to the patella by the usual technique, provided the amount of knee deformity has not been great enough to seriously shorten the total length of the biceps, which, with the low position of the patella, would render it difficult or would slacken off the tendon after the extended position of the leg was attained.

However, anyone who has had sufficient experience with this transplantation could estimate the tension with sufficient accuracy to approximate ultimately a fairly satisfactory function.

In this type of case, it is quite essential to correct the knee position first before attempting correction of the tibial torsion or any foot deformity, because the resultant joint alignment might not be as accurate, and it might not be necessary to realign the tibia, as the position may be a pure outward rotation of the whole leg without any intrinsic torsion in the tibia itself.

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# TREATMENT OF BONE AND JOINT TUBERCULOSIS*

BY E. G. BRACKETT, M. D., BOSTON, MASS.

The treatment of tubercular joint disease should have the definite aim of bringing the case, when possible, to that end result which will give to the individual a safe and permanently useful limb. To estimate the success of the treatment, one must determine what result should be considered as a real cure, and with that in view, judge how near the case has approached to that standard.

In the treatment in tubercular joint disease, the first object is to relieve the acute symptoms by whatever means are best adapted to the individual case and by the equipment which is at hand. The methods of treatment are of less importance than the results obtained by their use, by which the early or acute symptoms are relieved and the case is conducted into the quiescent stage. The carrying of the case into the quiescent stage, which at first occupies all the attention, is but an incident in the earlier treatment and must not be confused with the later and ultimate aim of treatment, which is to conduct the case to that end result which will give to the patient a permanently safe and useful joint. Too often we have been willing to accept a long convalescent stage as a cure, when it has been only a quiescent period in an imperfect result, for the ultimate aim in the treatment of a case should be to terminate the disease with that result which will give to the individual a permanently safe and useful limb.

The second object in the treatment is to determine what final result shall be the aim of the subsequent treatment. This question in turn leads directly to the decision as to what we are willing to accept in the different types and stages of tubercular joint disease as a safe and permanent result, and how and when that is to be secured.

To deal intelligently with joint tuberculosis, without reference to any particular joint, there are two factors to be borne in mind:

First, the necessity of a definite diagnosis based on all of the recognized methods of value, including the roentgenogram, and laboratory tests when necessary, in order to ascertain the existence of a tubercular rather than a non-tubercular disease. Also, when tuberculosis is found to exist, to distinguish an early primary synovial disease, in the stage before the essential articular structures are invaded, from a true articular disease, in which these

* Read at the Annual Meeting of the American Orthopedic Association, May, 1924.

essential structures are involved, whether the disease may have been primary in these structures or secondary by invasion or extension; and second, to have in mind what should be this safe and permanent end result. This will vary according to whether the case is one of early and arrested disease before destruction has occurred and in which return of function is possible, or of a true articular disease, in which the articular surfaces have undergone more or less destruction and in which the return of the actual function of the joint is not possible.

The methods employed, not only in the early stages but throughout the case, are not as important as the way in which the chosen method is carried out, and different means of treatment may and should be used at different times in the same case, or the choice of methods may be governed by necessities of environment, etc. The various methods which have been so strongly advocated must each possess virtues,—their able adherents cannot be entirely mistaken, for they all claim practically the same results, and the different means are best regarded as equipment to be adapted to meet the conditions found in the various cases and different phases of the cases which present themselves. There should be used whatever methods will best bring about the desired end, and to accomplish this, the principles of the different agencies and methods must be understood and what may be accomplished by them, particularly the conservative ones, in order that the case be given the benefit of their influence whenever and as long as it is possible, but not after their usefulness is over. As for instance, traction, indicated and so necessary in some phases and so efficient in the stage with spasm, may perhaps be continued too long after its need has passed, and, by the separation of the surfaces which it is first intended to effect, may prevent a firm apposition of the parts, and thus delay that desired bony union which a firm fixation may hasten. Pure fixation, by its rest to the parts and through its aid toward preserving firm contact, can hasten the ultimate process, and yet not be sufficient in stages of acute spasm and joint sensitiveness. Heliotherapy is claimed by many of its advocates to exert a distinct influence in producing, or at least in hastening, ankylosis, and this in addition to the general beneficial effect. Therefore, this should be employed, either with or without other means, as long as the desired effect is produced by its use.

In estimating the value of any method and the results, the amount of time consumed in obtaining the end must be reckoned, for the time has passed when the too prolonged convalescence can be regarded with equanimity, even if sometimes unavoidable, and particularly if the final result is not a permanently safe joint. Therefore, in determining what should be

regarded as a safe and permanent cure in joint tuberculosis, the decision as to the result which may be the aim must differ in the two stages or the two types of disease, that of early synovial disease, and that of destructive articular disease, and the object and the method will be widely different in the two. In the former, with the articular structures still intact, the aim must be the preservation of the integrity of the joint, with its motion, etc., with the object of restoring it to a useful status, for it is possible under the proper conditions to have an arrest of the process with subsequent repair and the restoration of the function of the joint. Therefore, in these early stages of the disease, the problem may be the arrest of the disease before serious destruction has occurred, for in such cases the aim is to restore the integrity of the joint with complete or nearly complete function and with the articular surfaces so preserved that an active use of the joint in later life is compatible with safety. Whether it is wise to attempt this will depend upon many conditions,—the extent of the disease, the age of the patient, the social environment, etc. But the choice is open. These cases must be watched with care, to detect at any time an involvement of the articular structures, and not mistake this type of joint tuberculosis for the quiescent period of the destructive stage, which may be only the beginning of a long convalescent period, and which may end in an imperfect joint, not capable of enduring the strain of later life.

When the articular surfaces of the joints are invaded, the problem changes, for in this type or stage of joint tuberculosis, it is not possible to plan for an unimpaired joint, for the damage to the structures has already been done, and at best it is possible to have a limb which will possess only a limited degree of functional activity of the two functions of weight-bearing and motion. Tubercular disease is destructive, and in these cases we are dealing merely with the remains of a joint in which normal function is not only not possible, but is unsafe. A joint which allows a little motion is continually subject to strain by movement, which forces it to beyond the limited arc allowed by the impaired structures, thus pulling or tearing the adhesions and submitting it to frequent strain, with danger of freeing bacilli encapsulated in the old scar tissues. Often, the less the motion, the greater the danger. Too often, in the long course of treatment of an extensive joint tuberculosis, the disease may remain in the quiescent stage for a long time under ordinary care and protection, but it is known that these imperfect joints with more or less destroyed articular surfaces, bound together with fibrous adhesions and allowing but a limited degree of motion, are particularly susceptible to strain and injury, limit the capacity of the individual, and give frequent periods of disability, and they must be looked upon

as sources of danger. Also, we know that these recurrences of the disease occur even after long periods of quiescence, and that when once these joints return to a condition of activity, they are persistent in their disability and require radical measures before they permit the patient to return to work, even to his previous grade of activity.

When the combined function of safe motion and weight-bearing is not possible, the reasonable aim of treatment is to preserve that part of the function which will make the limb safe for use, viz.: the weight-bearing function, and the problem then concerns the means of obtaining the best substitute for the lost joint, considering safety, permanency, and time. The true cure of joint tuberculosis which has passed into the destructive stage is a bony ankylosis, and anything less than this is a compromise and a constant menace. Since it is a fact that ankylosis of the joint in a destructive tubercular disease can take place either naturally or by the aid of operative means, this result gives the safety of after use, and, therefore, should be the ultimate aim of treatment in this group of cases. Looking at joint tuberculosis from this point of view, the problem of its treatment is different from that of formerly, for too often in the past have we been willing to accept a prolonged quiescent stage as a cure, instead of an imperfect result which will fail to endure the strain later to be put on it.

The increased facilities in diagnosis and treatment which exist to-day entail additional responsibilities on the surgeon, and, therefore, the problem which confronts the medical profession now is quite different from that in former times, when these larger opportunities for study did not exist. With the new means of studying the progress of a case, giving the opportunity to determine whether it is progressing toward an end result of ankylosis, a more intelligent course of treatment is possible and therefore demanded. The guides for decision in such a course of treatment were not possible before the perfection of the X-ray machines and other laboratory facilities, when the changes occurring in bony structures could not be determined, but it must be recognized that with the perfection of these new methods, a new responsibility is placed upon the medical adviser, and it is necessary that he realize his duty to readapt principles and accept a responsibility which could not have been put upon him when these means were not at his disposal. It is necessary that he consider the after usefulness as well as the life of the patient, when these two aims do not conflict.

With actual ankylosis as the object of the treatment in this type and to be attained at as early a period in the disease as is safe, or advisable and practical, the problem is to determine whether this ankylosis is occurring in the course of convalescence or must be induced, and if the latter, by what

means or methods and at what time (in what stage of the disease, and at what age of the patient). In arriving at the conclusion as to whether a joint long in the quiescent stage is progressing favorably and definitely toward ankylosis, the absence of the symptoms and signs of joint irritation give valuable suggestive information of the favorable progress, but the evidence determinable by roentgenograms is a deciding factor and should give evidence in regard to:—

(1) The amount of destruction in the joint; whether it has been sufficiently complete to bring the cancellous surfaces into contact, thus supplying the necessary conditions to bring about ankylosis, and whether by the roentgenogram it is seen that there is an increasing deposit of bone from time to time.

(2) Whether the two diseased surfaces still remain in contact, or have been so separated in the course of the disease that union is not likely to take place, such as, for instance, may be seen in some old and severe case of hip disease in which a sufficient dislocation of the head has occurred after the destruction of the acetabulum (wandering acetabulum) to allow the head to rest above on that portion of the ilium which has not been the seat of disease, in which case the conditions exist favorable for formation of a false or fibrous ankylosis, and a bony ankylosis is not likely to occur.

(3) Whether there remain portions of cartilage or sequestra to act as a foreign body interposed between the two surfaces and prevent ankylosis which might otherwise have taken place. These fragments of cartilage, etc., may act as a foreign body and in the same manner as a portion of fibrous tissue or muscle would act when interposed between the two ends of a bone in a fracture.

If the evidence indicates that ankylosis is taking place, and without too long a period of invalidism, the important indication in the treatment is to employ whatever means will most favor the rapid development of this ankylosis, and if possible to direct the treatment toward obtaining that position of the limb most favorable for after use. Often with some joints this latter purpose is difficult without sacrificing something in the treatment or in the freedom of the routine life of the patient. It is the opinion of many that in this case it is better to pay little attention to the position during this period, but direct all effort toward the early and firm ankylosis with the later correction in view. This plan has much to commend it, and it is sometimes necessary.

On the other hand, when the conditions favorable to result in true ankylosis do not exist, and when the evidence indicates that bony ankylosis is not being established by conservative methods, and the decision must

be made that measures to induce this bony union are desirable, the question of operative methods to bring this about must come up for consideration. There are then two other factors which must influence the final decision, namely:—the age of the patient, and the social conditions (economic environment).

The nearer to adult life, the less the question in regard to a decision, for less doubt will exist as to the advisability of operative interference to produce ankylosis in any joint at that age. It will be conceded by the majority of observers that in adults, after the quiescent stage of convalescence has been reached, the case almost decides the question for itself by the fact that the object is not only to restore the joint to a safe and active status, but also at the earliest possible moment in order to return the individual quickly to usefulness and to avoid a long invalidism. This decision, influenced by the fact that ankylosis in adult disease is rare, and is claimed by many never to occur spontaneously.

In adults with synovial disease, the course is somewhat debatable, but the long periods of disability, the removal from active life, the uncertainty of a safe result, are the strongest influences toward the decision to produce ankylosis and to give a quick return to activity. With destructive disease, the course is less debatable, for spontaneous ankylosis is unusual and the advisability of returning the patient to active life with a safe limb is imperative.

In children, the question will be more largely influenced by the social environment or the economic conditions. When these are such that the care necessary for the continued conservative treatment in a long tubercular joint disease can be thoroughly carried out, the decision to produce bony ankylosis may be less hospitably entertained at the younger age than in the case in which the social condition may prevent the treatment which demands prolonged care and persistence.

In children with spinal tuberculosis, the disease ordinarily progresses to a destructive stage. Particularly here the conditions of the environment play an important part in the matter of time, rest, hygiene, etc., and we know that true ankylosis can and does take place. Perhaps more than in any other type of joint tuberculosis, conservative means should be given precedence and long opportunity, particularly if the case is progressing along favorable lines; yet, on the other hand, operation does not remove any possible potentiality of function as in other joints, for it only influences the time of occurrence of the ankylosis, which is the desired final result.

With other joints the problem is different, and the decision must be made by balancing the evidence given by the important factors,—the age

of the patient, the social conditions, the chances of obtaining a useful limb, and the time necessary. There is developing a lessened reluctance to ankylose a child's joint when the choice lies, on the one hand, between a long conservative treatment, with the unfortunate general results (both physical and psychic) of restriction in the growing years, and even then with the uncertainty of a safe and useful joint, and, on the other hand, an ankylosis, and the quicker return to a life of greater activity.

Often the social environment will decide as to the question of age, but even when these conditions are such that the desired care be given, it must be borne in mind that if operative interference is attempted before the destruction is too great, the epiphyseal injury is less likely to occur and subsequent growth of the limb will not be interfered with; on the other hand, if operative treatment be delayed too long, it may endanger the epiphyseal junction and the end result in the case which had been given more time and care will be less favorable than in the one which had received less of the prolonged and conservative treatment.

In a destructive disease, something must be sacrificed of convenience to safety and permanency. One must determine what this is to be and many times that will be decided by the status of the individual in adult life.

In all cases, the element of time should have consideration: A long period of quiescent convalescence does not necessarily mean that the case is progressing to a safe and permanent end result. The general effects of a too prolonged invalidism are factors which have weight in making the estimate of a good or unsatisfactory result.

It is hardly possible to lay down fixed rules of procedure, for the cases are so individual that each one must be decided for itself. One can but apply principles to conduct the case to that end result by which the patient may be served in later life. We should consider in every case what is that result which, at the termination of the disease, will give to the patient a safe and dependable limb.

The important point to remember is that there is to be a definite result as the aim of treatment and this should be kept in mind throughout. Its object must be to bring the case to that termination that will give to that individual in the shortest time a permanently useful limb for his later life. It is most important that we must not confuse a long quiescent stage in the convalescent period, which is always vulnerable, with an end result of a safely ankylosed joint which will insure a permanently useful limb.

# THE END RESULTS OF STABILIZING OPERATIONS ON THE FOOT.*

BY LLOYD T. BROWN, M. D., BOSTON, MASS.

Because of the stimulation given by Hoke of Atlanta to the operations for stabilizing some of the joints of the foot, a series of these operations has been done by different members of the staff at the Massachusetts General Hospital. It was the writer's privilege a short time ago to see Hoke do some of these stabilizing operations. Since then the writer understands the reasons for some of the results recorded here.

In order to come to any definite conclusions in a comparative study of the end results of a series of stabilizing operations of the foot it is necessary to have a standard by which all the cases are judged. An examination of the report of the Commission appointed by the Association two years ago failed to give any such standard.

The main idea in a stabilizing operation of the foot is to correct the deformity and to put the bones in the best mechanical balance possible. Since, in such a bone operation, it is possible to reshape the bones in the joints that are operated upon, it should be possible to get practically perfect alignment. Therefore, all cases should be judged by the operator from the point of view of mechanical perfection. As will be shown later, all the patients when asked their opinion of the success of the operation as compared to the condition beforehand, were very much pleased and said they were better. But when these same cases were judged from the mechanical point of view they would not be given a rating that would at all satisfy a careful surgeon.

In this paper the report is only about the actual mechanical condition of the foot and its relation to the lower leg. Whether it was the proper type of operation for the foot condition in relation to the other conditions of paralysis present, is not discussed. Such a discussion would lead us into too long a paper and it would not be possible to emphasize certain points which have been found during this study.

The points studied for this paper were as follows:

1. Stability of the joints which were arthrodesed; (*a*) subastragaloid; (*b*) astragalo-scaphoid joint; (*c*) calcaneo-cuboid joint.

* Read at the Annual Meeting of the American Orthopedic Association, May, 1924.

2. Position of os calcis in relation to tibia and fibula.

3. Shape of foot.

4. Relation of the intermalleolar plane to the plane of the tibial condyles; torsion of tibia.

5. Comparison of the deformities before operation and the result after operation.

6. Patient's opinion of the result of the operation.

7. Mechanical result.

8. Suggestions as to necessity of further treatment.

1. Stability. This was judged by palpation and in some cases by roentgenogram. It is practically impossible to tell about the stability by

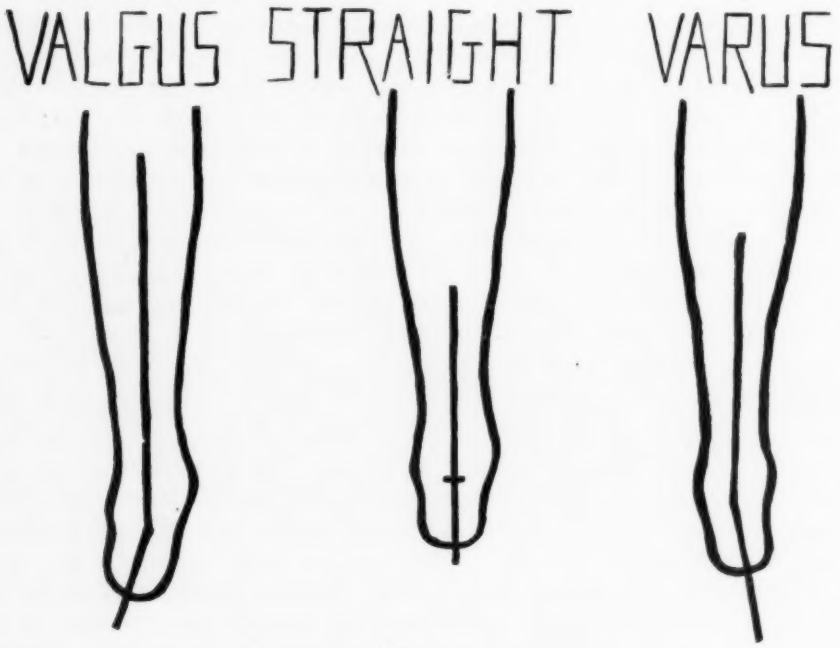


FIG. 1

means of the roentgenogram. By palpation, any amount of movement which would be of any mechanical disadvantage could be made out.

2. Position of the os calcis in relation to the tibia and fibula. This was studied very carefully both in the non-weight-bearing and the weight-bearing positions. If the vertical axis of the os calcis was such that it was a continuation of the axis of the tibia and fibula, the os calcis was

considered to be in a good mechanical position; if the axis of the os calcis at the lower end was to the inner side of the axis of the tibia it was considered in a varus position; if to the outer side, a valgus position. It was found that if the varus or valgus position was present without weight-bearing there was a strong tendency in most cases for the faulty mechanical balance caused by this to increase with weight-bearing. (See fig. 1.)

3. Shape of the foot. Under this heading was considered the relation of the forefoot to the posterior foot: was it straight, in varus, valgus, or was there any cavus? (See fig. 2.)

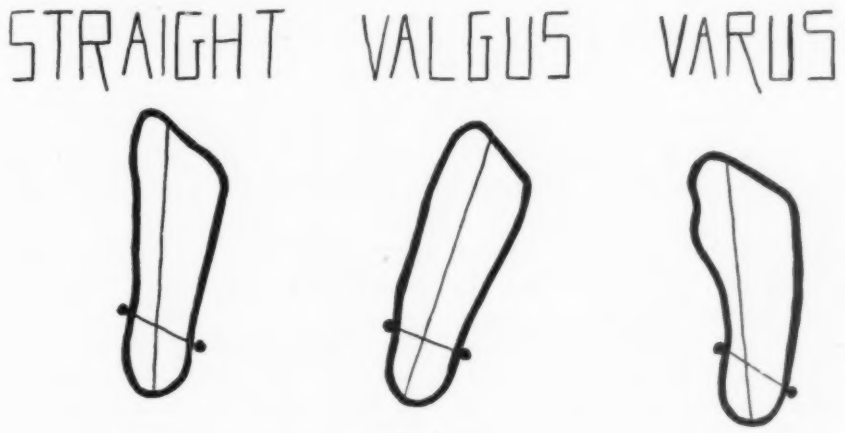


FIG. 2

4. Relation of the plane of the malleoli to the plane of the condyles of the tibia, the so-called torsion of the tibia. This was roughly estimated by judging how many degrees the external malleolus was behind the internal malleolus in relation to the plane of the condyles of the tibia. This is not considered of any importance, but was taken to find out what conditions were present.

5. A comparison of the deformities of the foot before operation and the result after the operation brought out some interesting points.

6. Patient's opinion of the result of the operation. Each patient was asked if he were satisfied with the result or if he would like it any different.

7. Mechanical result. A result was considered good if the arthrodesis of the joints operated upon was firm, and if the foot was in good alignment not only as to the relation of the os calcis to the axis of the tibia but also of the forefoot to the posterior foot, such as a varus, valgus, or cavus.

8. Suggestions as to necessity of further treatment. Further

treatment was suggested if it was considered that the mechanical alignment could be improved with advantage to the patient from the point of view of weight-bearing several years from now.

The results of this paper are based on the study of twenty-five patients on whom twenty-seven operations had been done. There were other cases which it was not possible to examine, although letters were received from them, which are, of course, not included in this study.

There were thirteen males and twelve females. The average age of the patients was 16.8 years.

The average length of time since operation was 12.9 months.

## CONCLUSIONS

1. Stability was obtained in all the cases attempted. Although the functional result was good in twenty cases and fair in five, the mechanical position in which the arthrodeses took place was good in only six cases, fair in six, and bad in fifteen. This means that more attention should be paid to the position in which the joints to be arthrodesed are put in at the time of the operation, or that the first position be corrected as soon as it is found to be unsatisfactory.

2. The relation of the vertical axis of the os calcis to the axis of the tibia was found to be straight in six cases, in valgus in six, and in varus in fifteen cases. Although the functional result was good in nineteen and fair in six, the mechanical result was good in only four cases, fair in eight, and bad in fifteen. As said above, when there was a varus or a valgus position without weight-bearing, there was a tendency for this faulty position to increase with weight-bearing. The importance of obtaining the straight position must therefore be remembered at the time of the operation.

3. The shape of the foot as judged by the relation of the forefoot to the posterior foot. Our results showed that only one foot was straight, eighteen were in varus, six in valgus, and one in cavus. From the functional side, however, eighteen were good and eight fair; from the mechanical side, three were good, seven were fair, and fifteen were bad.

4. Torsion of the tibia. This condition, as shown by the backward displacement of the fibula on the tibia, was found to be normal in ten cases, moderate in ten, and extreme in seven. This was measured roughly with a goniometer. The relation was considered normal if the lower end of the fibula was 20–30 degrees behind the plane of the tibial condyles; moderate if 30–50 degrees; and extreme if 50–70 degrees. The functional result was found to be good in the normal cases seven times, and in those cases with

a moderate backward displacement seven times, and fair in three times each. In the cases with the extreme backward displacement the functional result was good in four and fair in three cases. The mechanical result was good in the normal cases in two, fair in two, and bad in six. In the moderate conditions it was good in one, fair in two, and bad in seven. In the extreme cases it was good in one, fair in two, and bad in four cases. From this it would seem that the amount of tibial torsion present was of not much importance, at least from the functional point of view.

5. A comparison of the deformities before operation and the result after operation brought out the following: In four equino valgus cases the functional result was good in three and fair in one case. The mechanical result was good in one, fair in one, and bad in two cases. In sixteen equino varus cases the functional result was good in ten, fair in six. The mechanical result was good in two, fair in two, and bad in twelve cases. In four cases of varus with cavus the functional result was good in three and fair in one, while the mechanical result was good in one, fair in two, and bad in one.

6. The functional result or the patients' opinion of the condition showed that nineteen, or 70%, considered their result good, and eight, or 30%, considered their result fair. None of them thought they were worse.

7. The mechanical result as judged by a combination of all the above examinations taken together showed that five, or 18%, were good; six, or 22%, were fair, and sixteen, or 59%, were bad.

8. Suggestions for treatment:

Greater care should be taken at the time of the operation to insure the foot being put into the best mechanical alignment possible. It should be possible to get the os calcis into a straight position if the operation is done properly. It may not and very often will not be possible to get the forefoot in the proper relation to the posterior foot at the first operation, but it is the duty of the surgeon to see that this relationship is established before the patient is discharged from his care. This should be possible to accomplish by manipulation or corrective plasters if it is done within six to eight weeks after the first operation and it should always be done.

As orthopaedic surgeons we should not be satisfied with pleasing the patients by making them better than they were before. We should be satisfied only by doing an operation and following up the after-treatment in such a way that the patient gets a result that is mechanically as perfect as possible. In this kind of work anything less than this means that we have not lived up to the standards which we should always have before us.

## DISCUSSION ON PAPER OF DR. BROWN.

DR. ARMITAGE WHITMAN, New York City: I am at a disadvantage in attempting to discuss this paper because I was so unfortunate as not to be able to get to Atlanta last spring to see Dr. Hoke's work, and also I have seen none of the cases reported on. There must be some explanation for these lamentable results which Dr. Brown describes, which I think must be undue pessimism. Possibly he stresses the mechanical a little too much at the expense of the functional result. After all, if the patients are satisfied with 70 per cent. functional result, he has no cause for self-depreciation. I think we can take it for granted that Dr. Hoke's operation is a good one. I think we can also take it for granted that the members who operate on these cases at the Massachusetts General Hospital possess a fair degree of skill. The only explanation for the bad results may be that the patients who had bad lateral deformities did not have the deformities corrected before the operation was done. It has always seemed to us at the Hospital for the Ruptured and Crippled that it was important to do this either by hand or by the Thomas wrench. We never do a bone or cutting operation until the deformity of long standing has been entirely corrected.

There are two questions I should like to ask, although perhaps they are not directly pertinent to this paper. The first is, does the operation in question limit dorsal flexion of the foot at a right angle in the case of a dangle foot? Second, is such limitation of motion considered of any importance? I think it is important to bring up the point because certain patients with dangle feet may thus be taught to walk in practically a normal manner without any apparatus. We believe also that in cases of quadriceps paralysis the operation accomplishes the same result in locking the knee as the prevention of the "back knee" by osteotomy of the femur, the operation of Dr. Davis.

DR. O. L. MILLER, Gastonia, N. C.: I always enjoy an opportunity to endorse foot stabilization, especially after the method of Hoke. It was my privilege to be with Dr. Hoke when he developed this operation and to see him apply it to many cases. I have done about 250 of these stabilizations in my own clinic and feel that this stabilization operation as it has been developed is the greatest surgical contribution to the treatment of infantile paralysis. I have now seen it work in some 500 foot cases.

I got the impression that Dr. Brown's results were a little pessimistic and I am sorry that he gave me that impression. I do not think that ought to be the case.

None of the feet are going to be one hundred per cent. perfect or normal, but with this stabilization operation in our experience we get the maximum improvement. There has been some question about the efficacy of the procedure in the equinus type of flail foot but when the operation is done, together with shifting the foot backward, good stability is secured—as good for me as any procedure. The varus foot and flat foot work out well, if the operation is applied in an understanding way and the necessary tendons transplanted; all deforming factors must be met in the entire leg and foot. For me it turns out a well balanced and good functioning calcaneus foot, and this is the hardest type of paralytic foot to treat.

DR. FRANK DICKSON, Kansas City, Mo.: I think some of the implied pessimism in Dr. Brown's paper is due to the fact that he has taken as his criterion a mechanical factor, which is a perfectly straight alignment of the foot with the leg. As a matter of fact, my experience in stabilizing feet is that a moderate amount of valgus is desirable and gives a more stable foot than a correctly aligned one; particularly in paralytic cases.

The foot which is in varus, even of a slight degree, is the foot which gives trouble. The fact that Dr. Brown admits that even without a straight foot the patients were pleased with the result indicates that functionally the stability secured was satisfactory, even if mechanically slightly incorrect.

Dr. A. F. Moxey, Philadelphia: Just one suggestion about securing the maximum result in this operation. In Philadelphia I have established this procedure: If in doubt about the position of the foot following an arthrodesis, I have adopted the plan of changing the cast at the end of two weeks. Some of those cases classified by Dr. Brown as poor results could possibly have had the position of the foot corrected two weeks after operation. The mere matter of changing the cast, if the surgeon is in doubt as to the ultimate position of the foot following an arthrodesis operation, permits in two weeks the dressing of the wound and the correction of whatever deformity may be present and the application of a new cast which will hold the foot more securely during the remaining period of immobilization.

Another point that one should consider, and that I have developed recently, is a combination of subastragalar arthrodesis with an arthrodesis of Chopart's joint. All of us have seen cases following subastragalar arthrodesis in which the os calcis and astragalus are straight, but in which there is pronation or supination and sometimes adduction—a torsion, as it were—of the fore-foot, which is not corrected by a simple subastragalar arthrodesis operation. This deformity is corrected, and its return prevented, by the performance of a mid-tarsal arthrodesis (through Chopart's joint), either coincident with or subsequent to the performance of the subastragalar arthrodesis. I have had cases in which this was done, either as a combined or as a two-stage operation, with excellent results.

These two suggestions—of changing the cast two weeks after operation, correcting manually any malposition of the foot found to be still present, and the performance with the subastragalar arthrodesis of a secondary midtarsal arthrodesis—should always be borne in mind; for by such methods we secure better functional results for the patient.

Regarding whether dorsi-flexion of the foot is or is not limited, I feel that if the operation of horizontal transverse section is properly performed, dorsi-flexion of the foot is always mechanically limited thereafter.

Dr. Charles L. Lowman, Los Angeles, Calif.: It has been our experience, and I have been following Dr. Hoke's work since 1915, that our bad results are due to having the assistants, instead of the operating surgeon hold the foot. Another thing: in closing up the external wound after subastragaloid arthrodesis if the stitches are pulled too tightly there is a tendency to close the osteotomy gap and to bring the foot over into valgus. Those are the chief things we have had to contend with.

Dr. F. J. Gaenslen, Milwaukee, Wis.: I do not think Dr. Hoke needs any one to defend his stabilizing operations for the foot, but I will say that during the past two or three years I have used his technique as described before the Association with a great deal of satisfaction. I know of no operation that will allow so perfect a remodeling of the architecture of the foot as the Hoke operation. Lateral deformity of either varus or valgus is readily taken care of by proper inclination of the chisel in attacking the astragalo-calcaneal joint. I have had some difficulty because of a recurring varus deformity in certain cases. Whitman, after his astragalectomy, puts up the foot in slight valgus, no doubt because of the same tendency. The foot in slight valgus is a

good weight-bearing foot. A straight foot is no better as far as weight-bearing goes. The varus foot is disabling. We want to get either a straight foot or one in slight valgus for good stability. I believe that recurring varus may result from strong toe flexors, the long flexors and especially strong short flexors of the toes, if arthrodesis is not secured early. During this initial period there may be a gradual transformation of the foot which has been placed perfectly straight in the plaster, resulting in slight varus deformity. As a valgus foot is a good weight-bearing foot I am now putting them up in slight valgus where there are strong toe flexor muscles.

DR. LLOYD T. BROWN, Boston, Mass. (closing the discussion): I am sorry to bring a spirit of pessimism into this otherwise cheerful party. I certainly have no pessimism about it. I think if you look at things from a functional point of view you will consider our results as good as any one's—70 per cent. good and 30 per cent. fair. I do not think you will find any better. The chief thing I want to bring before you is this: If you are going to try to correct a faulty condition of the foot and you are going to do it by operative means, you should not be satisfied only with the functional result you get. You should be satisfied with getting only the very best thing possible. Now a foot with the os calcis in a varus position will have less strength than one in valgus or straight foot. If you take any series of cases and go over them from the point of view of mechanical alignment, I think you will find that you have reason for pessimism, if you think what I have given you is pessimism. Personally I do not think it is. I think it is one more way of judging our cases. Dr. Hoke is right when he says if you decide to do any operation on the foot, work out what you want to do and then do it.

# THE TREATMENT OF SCOLIOSIS BY A DIFFERENT METHOD FROM THAT USUALLY EMPLOYED.*

BY R. W. LOVETT, M.D., AND A. H. BREWSTER, M.D., BOSTON, MASS.

In the following paper it is our purpose to present a report of progress in the use of a method for treating scoliosis which employs, we believe, a different application of force from that used in existing methods, and which in our hands has proved more effective in securing rapid correction of moderate cases of structural scoliosis than any form of force we had used before.

The first jackets applied by this method by us were put on in the winter of 1923-24, so that even the oldest cases reported are comparatively recent and the majority of them are of two or three months' duration. For this reason it is impossible to report late results. Therefore this paper is spoken of as a report of progress.

The results are presented in the form of roentgenograms, inasmuch as it is generally recognized that this is the most correct presentation of a case. In photographs it is well-known that the thorax may be displaced on the spine while the spine itself remains unchanged. We are really concerned with the behavior of the spine and not with distortion of the thorax.

In our clinical work we have attempted to see what could be done in all grades of cases, and in the figures it will be shown that in the severer cases little or no improvement has been obtained. The other cases speak for themselves. In general we do not regard very severe cases with marked wedging of the vertebrae as being especially affected by this or any other mode of treatment. In cases where the apex is above the middle dorsal region we have been able to do very little, although it is possible that with an improvement of our technique we may be able to exercise high corrective pressure.

We would probably all agree that the aim of any corrective treatment should be: first, to secure the maximum correction, or over-correction if possible, as speedily and as comfortably to the patient as practicable, and secondly, most of us would agree that such position should be continuously maintained for a long time, on the ground that growing bone is plastic

* Presented in Abstract at the Baltimore Meeting of the American Orthopedic Association on May 16, 1924.

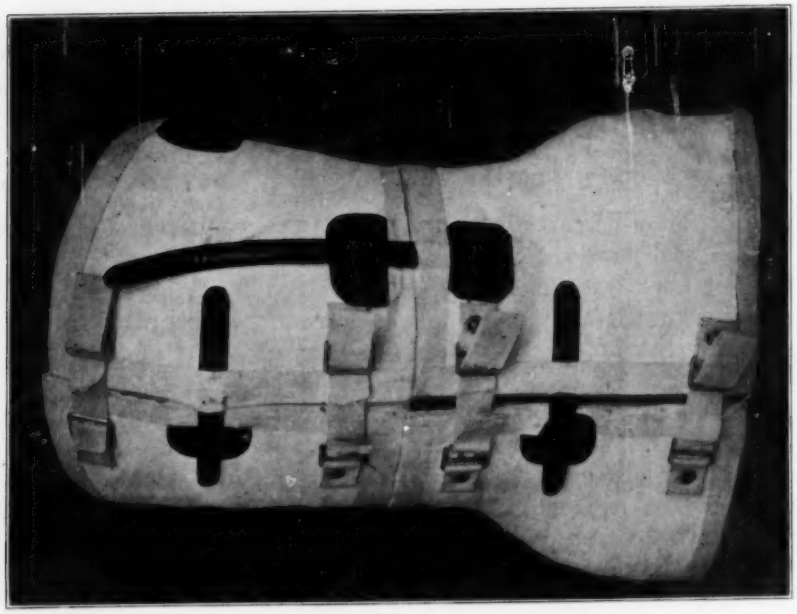

FIG. B

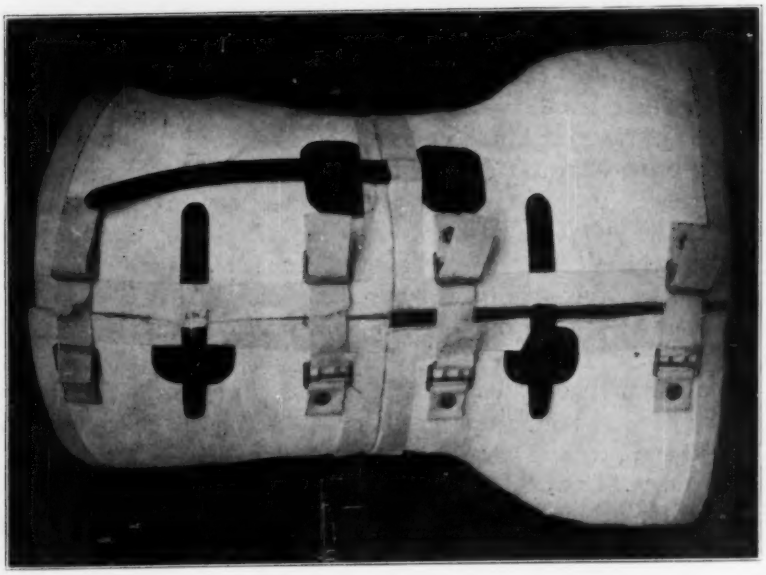

FIG. A

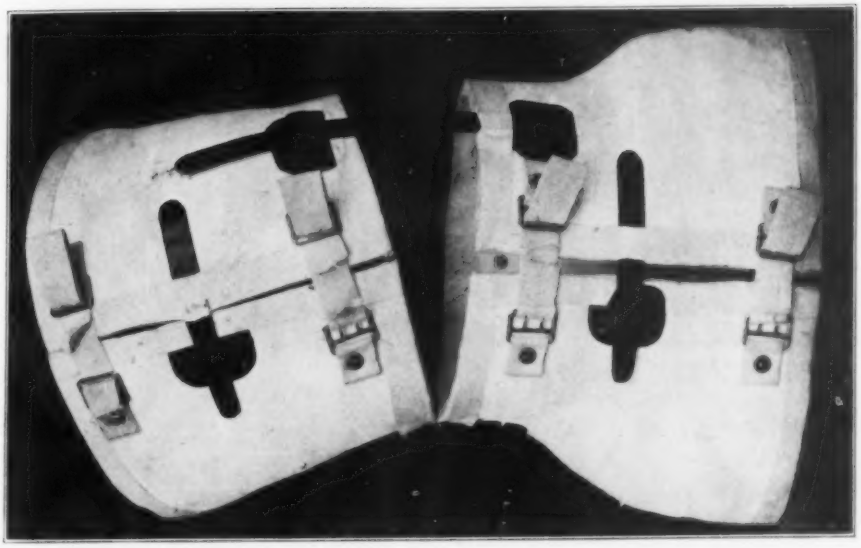

FIG. D

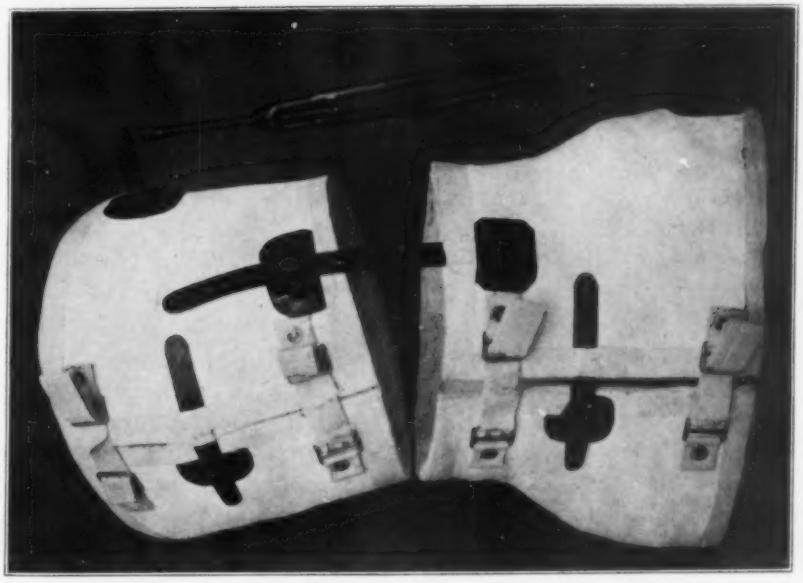

FIG. C

FIG. 5A

and that Wolff's law held out hope that the prolonged maintenance of such position offered hope of a permanent change in the shape and relations of the vertebrae before adolescence. That this proved to be the case in a certain number of cases corrected by another method was shown by Schanz.[1]

In our previous method of treatment we had been making lateral

FIG. 5B

pressure upon the prominent part of the thorax and applying a jacket under this pressure. But when we reached high degrees of pressure the skin rebelled and caused us trouble, so that to use greater force along those lines was not practicable, and especially the results obtained in this way were not striking. The curved part of the spine from a mechanical point of view constitutes an arch, and an arch is most resistant to pressure coming

FIG. 6A

upon its apex vertically. This was the application of force that we were using.

It occurred to us, therefore, instead of pressing laterally on the arch with fixed counter points above and below it, to use the apex of the curve as the fixed point and to bend the spine above and below it on that as a fixed point.

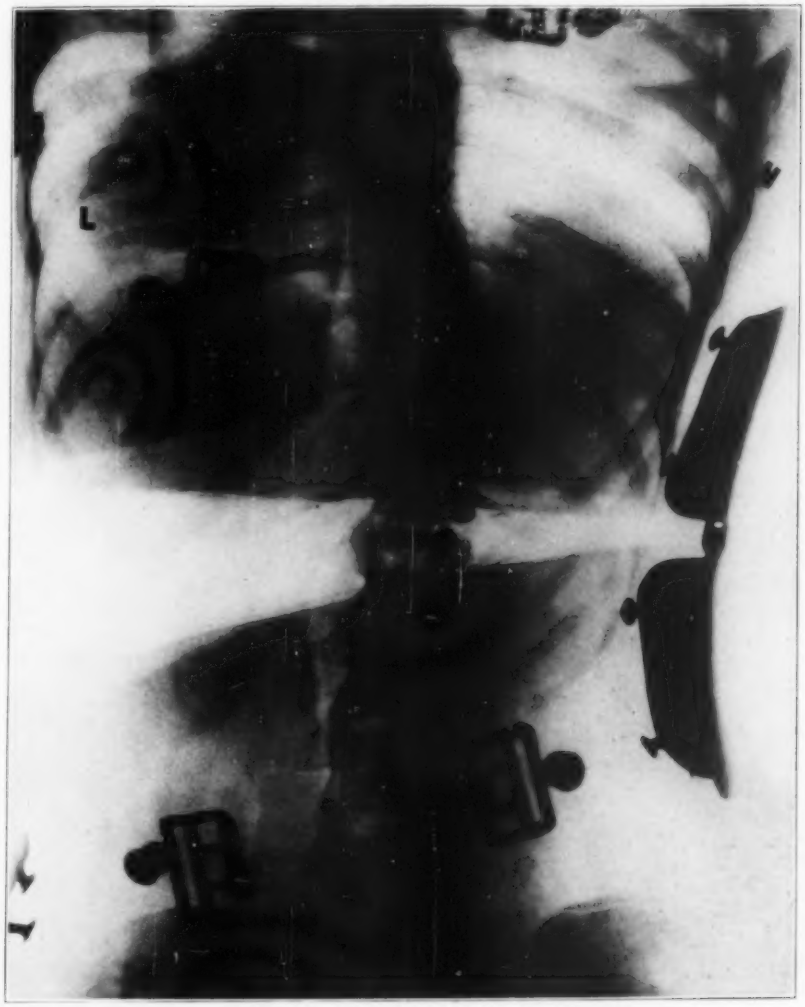

FIG. 6B

Professor Ira N. Hollis, President of the Worcester Polytechnic Institute and formerly Professor of Engineering at Harvard, has been good enough to advise us on the purely mechanical aspect of the matter. As well as we can formulate it, we are using the same kind of mechanical force as in the old method, but we have a much wider distribution of the

FIG. 7A

three areas on which pressure is exerted when we use the turnbuckle jacket. If one were attempting to break a curved iron rod one would use point pressure in three places: one, at the maximum of the curve; two and three, as near both ends of the rod as possible. If we were trying to bend the rod we would distribute the pressure in each of the three regions as widely as possible, so that formerly we were using pressure better suited to breaking than to bending.

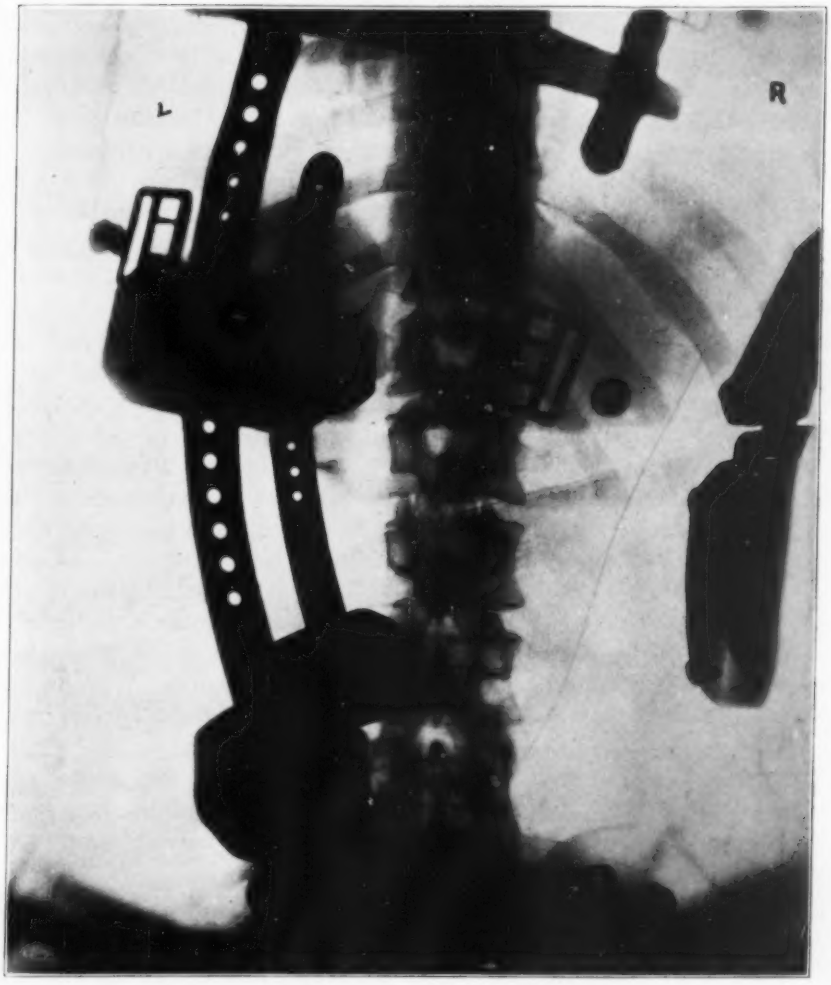


FIG. 7B

We feel, therefore, that the first point of advantage is a more widely distributed pressure at the three areas where pressure is desired. Secondly, in the hinged jacket we are using an excentric. The hinge at the periphery of the jacket does not correspond to the centre of motion in the spine and the jacket is lengthened when it is opened, producing distraction of the spine above and below the part opposite the hinge. This we believe to

be an advantage. Thirdly, we are using an almost irresistible mechanical force by means of screw pressure. Fourthly, and this seems of much importance, it will be noticed that the rotation is markedly diminished in the corrected cases although *only* lateral force was used. This is apparently because the rotation and lateral curve are parts of one whole. Finally, by a very simple change in adjustment, the same jacket will serve as the permanent jacket to maintain overcorrection.

For the manufacture of the jacket the patient is suspended by a head-sling with the toes touching the floor, and a close-fitting plaster jacket is applied which extends from the axillae to below the greater trochanters, care being used to mark out the anterior superior spines and the crests of the ilium. The jacket is immediately cut off by a vertical incision in front. A few more plaster bandages are then wrapped around this to preserve its shape. This plaster jacket is then filled with plaster. The plaster torso is trimmed, shaved, and filled, as described by Lovett and Sever,[2] so that the finished torso represents the patient in a somewhat better position than was obtained in the jacket itself as originally applied. On this corrected torso a plaster jacket is then applied and immediately removed by a mid-line cut in front. After this has dried and before it is tried on, enough has to be cut off at the top to make it comfortable under the arms, and enough cut from the bottom to make it possible for the patient to sit with comfort.

If it proves to be comfortable, this jacket is then divided transversely at the level of the apex of the lateral curve and fastened together by a garden-gate hinge at the side of the trunk, which allows the jacket to be opened on that as an axis. On the other side a turnbuckle connects the two segments, fastened to the jacket by iron boxes, and the turnbuckle is so arranged that it is removable and can be pulled out when the patient has been placed in the correct position.

At first we were obliged to use two jackets—one with the turnbuckle and the other for a corrective jacket to maintain a somewhat improved position. But it was evident that this was a weak point in the method and that an adjustable jacket should be made which was capable of maintaining any degree of desired overcorrection for continuous wear. For this reason the turnbuckle, as has been said, was made removable and the jacket was furnished on the side which was opened with two adjustable locks holding the upper and lower parts at any desired angle to each other.

The method in use at present is that of a combined jacket with a removable turnbuckle and the locks. The patient takes from one to two stretchings a day by means of the turnbuckle, and it may be well to remind

the surgeon that in using this turnbuckle a very high degree of force is at his disposal and that it is wise to go slowly at the first application. The stretching periods which we have used are from half an hour to an hour and a half a day, and at the close of each period the jacket is locked in the most corrective position comfortable and the turnbuckle removed. This simplified matters very much because it was impossible to wear clothes over the turnbuckle. By the method of construction with the locks, which will be seen in the illustrations, the jacket can now be worn under the clothes without especial disfigurement, except the asymmetry of the whole position, which is not so noticeable as one would think. It is also necessary to secure sufficient stability to put on certain strips of steel, which are shown in the illustration. Without these, the jacket is not sufficiently firm to exercise the desired pressure. We have had no unpleasant complications and no trouble with the skin.

This report is presented with all modesty and diffidence, with the full recognition of the writers that they have no end results to show and that until such results can be shown it is not wise to claim too much. It may be repeated that this method will not, in our opinion, at present reach the cases in the upper dorsal region, and secondly that we have no reason to expect that it, or any other method, will do much for severe and ankylosed cases. What we would claim for it is that in our short experience it has proved a useful and comfortable method of securing definite correction, and sometimes overcorrection in suitable cases, that a very high degree of force is at the command of the surgeon by means of great pressure, that the construction of the jacket is such that in correction a marked distraction of the spine occurs, and that rotation is markedly improved without the use of any twisting force.

The use of gymnastics and manipulations of a heavy kind we regard as a very desirable part of this treatment.

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[1] Schanz: Verhandl. d. deutsch. Ges. f. orthop. Chir., 1908, p. 57. Wullstein: Ztschr. f. orthop. Chir., 10:2, 1902.

[2] Lovett, R. W., and Sever, J. W.: The Treatment of Lateral Curvature of the Spine. J. A. M. A., 57:786, September 2, 1911.

# SUBSEQUENT REPORT ON THE TREATMENT OF STRUCTURAL SCOLIOSIS AT THE MASSACHUSETTS GENERAL HOSPITAL.*

BY ARMIN KLEIN, M.D., BOSTON, MASS.

The patients considered in this report, afflicted with structural scoliosis arising from unknown or indefinite causes, apparently have been corrected with exercises and plaster jackets and held so by a steel brace. They are a sample of results from conservative methods, observed over a period of eighteen months to three and one-half years. They have been from seven months to almost two years without any avowedly corrective treatment. Some of these cases were reported two years ago during the period of active correction of their deformity. At that time and since then some authorities have claimed that though these types of cases might be actually somewhat improved, that this improvement could be maintained only by a corrective jacket, and that any brace would allow a certain amount of relapse. Because of this difficulty of retention, and to shorten the period necessary for the treatment of the ailment, they have advocated fusion operations of the spine.

The difficulty of retaining correction, however, in patients treated conservatively has been exaggerated. It would seem to us that the patients shown here and others like them have not retrogressed since the corrective jackets were omitted, and if anything, correction has continued in the brace. If this is so, the advisability of an early fusion operation can indeed be questioned. As can be seen, it takes a long time to effect the apparent straightening of the spine. If this type of spine is fused, as has been advised, after only four to eight weeks of preliminary corrective treatment, the fusion will very often ankylose the spine before the full amount of correction is attained. With case H. W. (Figs. 3A-B-C and 4A-B-C) as a concrete example, it is plain to see that if fusion had been done at any time during the treatment a definite amount of improvement in body symmetry would necessarily have been sacrificed. Then it would also seem not unreasonable to expect that with growth in height a greater increase would accrue to such a scoliotic spine not fused, so long as it were guided in its growth by an efficient brace, like the growing sapling directed by the rod to which it is tied.

* Read at the Annual Meeting of the American Orthopedic Association, May, 1924.

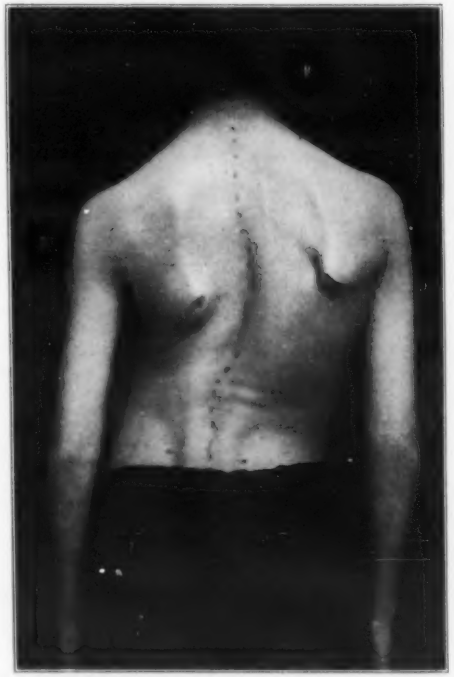

FIG. 1A

N. C., aged 14. The first corrective jacket was applied one month later. Note the comparative levels of the scapulae; and that the left hip is more prominent while the right hip is overhung by the right shoulder.

FIG. 1B

N. C., fifteen months later and just prior to wearing a steel brace. Note that the right hip is now more prominent and that the hollow concavity on the left has disappeared. Patient is going to school while being treated.

FIG. 1C

Patient is now 17 years old, has been almost two years in a steel brace and has been working in a shoe factory.

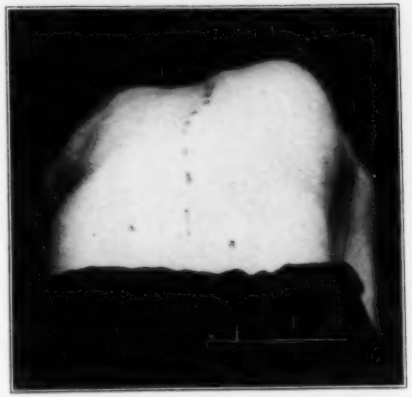

FIG. 2A

N. C., aged 14. Note the hollow concavity of the left side and the posterior convexity of the ribs on the right.

FIG. 2B

N. C., 15 months later. Note that the concavity on the left has disappeared and that all evidences of rotation in the forward bend position have apparently disappeared.

FIG. 2C

N. C., after almost two years in a steel brace.

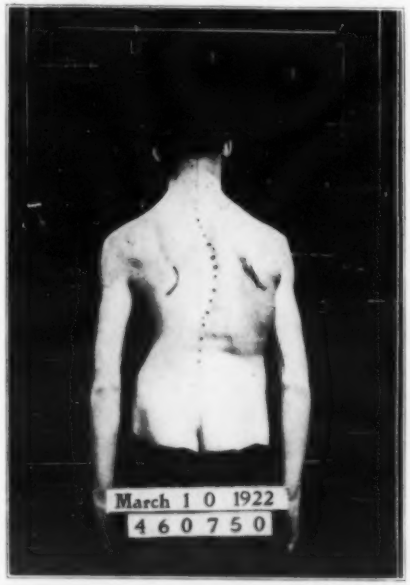


FIG. 3A

H. W., aged 18. Note that the right scapula is somewhat higher than the left and also that the left hip is the more prominent one, while the right hip is overhung by the shoulder, and thorax. In the following five months the patient gained ¾ of an inch in height.

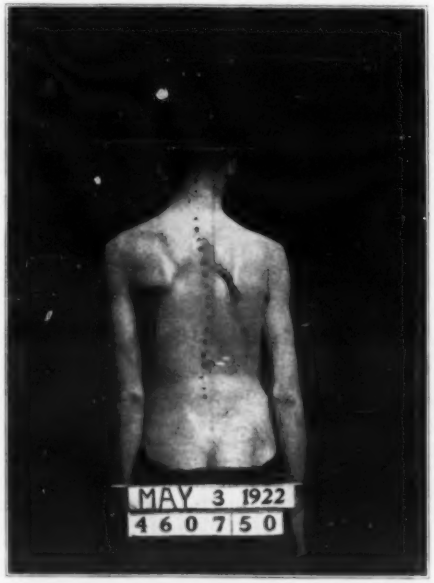


FIG. 3B

H. W., about eight weeks later, after two corrective plaster jackets. Note the more symmetrical appearance of the trunk and note also that the right hip is now becoming more prominent. Patient was now put into a "straight jacket" and continued his work at the bank.

FIG. 3C

H. W. Patient is now 20 years old and has been almost one and one-half years in a steel brace. All this time he has been rarely to the hospital. He has not stopped work in the bank during the entire period while under observation and treatment. Note now that the right scapula is lower than the left, and that the trunk has been warped over to the left so as to make the right hip prominent.

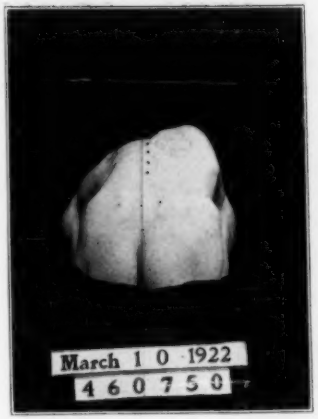


FIG. 4A

H. W., aged 18. Note the marked evidences of rotation — the posterior convexity of the ribs on the right.

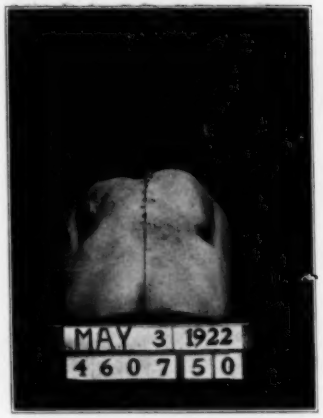


FIG. 4B

H. W. Note here that the right posterior convexity of the ribs has become markedly less prominent and that the left side of the chest has expanded a great deal.

FIG. 4C

H. W. Note that the posterior convexity of the ribs on the right has been markedly reduced while the patient has been in a brace. Note also the distinct improvement in the left or concave side of the chest.

The method by means of which the corrections shown above were attained is truly a safe and ambulatory one; for the patient is not confined to bed at all during the treatment. In fact, it is stipulated with the patient when treatment is started that he or she must continue his usual mode of living, or treatment will be discontinued. Thus, the patient is not withdrawn at all from his particular routine of life, and, in fact, has the opportunity while being treated to advance at the same time his position in his own surroundings, be they what they may. And, of course, while ambulatory, the patient has, as is strikingly shown in very many of our cases, often improved his general health and resistance. The constant breathing exercises while the body is held by the plaster cast in the improved position result first of all in the widening of the intercostal spaces. All this means a freer activity for the thoracic organs, which are usually cramped in scoliotics; and also a better stimulation, through increased diaphragmatic action, of the intestinal tract. The final result of this corrected body mechanics is a general condition so improved that the patient himself is readily cognizant of it.

The method of correction is in itself very simple and practically without any discomfort to the patient. It is a slow process, consisting of a period of concentrated exercising followed by another period of alternating corrective plaster jackets and exercising. In this way there is no marked atrophy and the general condition of the patient throughout is really better than what was normal for him before treatment was instituted. In reality, the treatment is not strenuous, but rather leisurely. The key-note is gradual progression through constant repetition. With the consequent freedom from any discomfort during treatment the patient finds himself eager to coöperate as he goes about his daily activity, though still under treatment. In no case is a cure expected or attempted. We aim solely for an improvement in body symmetry to insure a better state of nutrition and health. Then with proper training the muscles, with the aid of a brace, can compensate for the deformity.

## TREATMENT.

First of all, after a routine examination of the patient, and after the compilation of previously described records,[1] the patient is started on exercises. He rests for twenty minutes after each meal, lying flat on his back on a table or on the floor. Then he goes through breathing and other mobilizing exercises for about fifteen minutes each time. In this way the tightened ligaments and muscles of the trunk are loosened, and at the same time the patient gradually acquires control over his respiratory muscles. By a con-

stant repetition, particularly of the breathing exercises, a force is cultivated, powerful in its single expression but manifestly of paramount value because of its involuntary continuous repetition over twenty thousand times a day. It is on this force carefully nurtured beforehand that we rely for correction

FIG. 5

Patient with a right dorsal-left lumbar scoliosis, held in frame, ready for application of fenestrated plaster jacket as soon as felt padding is placed. Note position of the right shoulder, causing the ribs of that side to open up.

of the patient's symmetry while he is in the plaster jacket. Usually it takes from one to six months of concentration on the mobilizing exercises before they have been well learned and the respiratory force has been brought under the patient's voluntary localized control. Only then is the corrective plaster cast applied.

The patient lies flat on his back on a hammock in the Abbott[2] frame.

The pelvic girdle, by means of the lower extremities, is rotated away from the direction of the dorsal curve of the spine and is held so by a three-tailed cotton swathe. This swathe completely encircles the pelvis and is attached to the side bars of the frame. The shoulder girdle is also held rotated in the direction opposite to the twist of the pelvis; i.e., towards the side of

FIG. 6A

FIG. 6B

Plaster jacket on patient, with a right dorsal-left lumbar scoliosis. Patient is held with the shoulder girdle rotated to the right and the pelvic girdle rotated to the left.

the convexity of the dorsal curve. Thus, as shown in figure 5, if the patient had a right dorsal, left lumbar scoliosis, his shoulders would be turned to the right while the hips were turned to the left and very often, practically, at right angles to each other. This position is based first of all on the work of Lovett[3] and Calvé.[4] The former showed that there was little rotation normally possible in the lumbar spine; in fact, that it was "extremely limited." Calvé demonstrated the absence of rotation in the lumbar spine and showed how this and the pelvis formed an "actual rigid block to rotation." Therefore, rotation of the pelvis as in the position described above should be transmitted through the lumbar spine directly to the dorsal spine. The rotation of the shoulders towards the dorsal convexity, as Feiss[5] and Forbes[6] showed, brings the peripheral stress of the body-wall enveloping

the concave side of the thorax to bear, as a force, on the ribs of that side. The spring tension of these ribs is increased by the stress of the taut parieties over them, acting at "a" on figure 11, and there results a backward movement of the rib wall at "b." Then by transmission through the transverse process on that side there should result a derotation of the vertebra. With the decreased spring tension on the other side there should follow more or less of an advance of that half of the chest. Now then, as the patient lies in this position his thorax is warped over to the concave

FIG. 7A

FIG. 7B

Instrument for insertion of felt padding. The handle is of ⅝ inch brass pipe. The guard is of soft untempered steel 3½ by 2 inches and rounded at its corners. The blade is also of soft untempered steel 1¼ inches wide, ⅛ inch thick and 16 inches beyond the guard and rounded at its distal end. The proximal end of the blade passes through the guard and is inserted and brazed into a slot cut for it in the distal end of the handle. The proximal end of the handle is blocked with a brass block that is "sweated" in with solder. The entire instrument is then nickel-plated.

FIG. 8. SCOLIOSIS BRACE.

The sacral pad (A) is of 14 gauge aluminum, padded with two layers of felt and covered on the body side with gray sheepskin and on the outer side with case leather.

The pelvic bands (B) are of 18 inch gauge, tempered steel ½ inch wide, fitted to pass — after leaving the sacral pad — over the crest of the ilium around and beyond the anterior superior spine and then above the greater trochanter, back to the sacral pad. These pelvic bands are covered with a single layer of felt and gray sheepskin.

The rear upright (C) is of 16-17 gauge steel, 1 inch wide and not tempered. It is blued and polished in the Bunsen flame and covered on the body side with one layer each of case leather and felt.

The top bar (D) is of 17-18 gauge steel, 1 inch wide, blued and polished and covered with one layer each of case leather and felt.

The swathe (E) is 4 to 5 inches deep, of double canvas, stitched and bound on all four sides. It is riveted to the side upright (F), passes across the posterior convexity of the ribs and hooks around the rear upright with its lower margin passing through an aluminum gauge (G) 1½ inches long and ¼ inch wide. Thus, downward sliding of the swathe is prevented. Two strips of ⅞ inch webbing are sewed to the free end of the swathe and are pulled through buckles sewed on the swathe. A pad of felt and case leather 4 inches wide and 6 to 7 feet long is riveted to the body side of the swathe at the site of the apex of the posterior prominence of the ribs. Thus when the swathe is pulled taut, the pressure at the point of contact of the pad on the hump of the ribs is a steady even one.

side so that in effect the shoulder on this side of the thorax is stretched to the extreme, away from the pelvis. But in spite of this extreme stretching, as the arm of the other side is still up—note the right shoulder in figure 5—the chest on this formerly convex side is not deformed in the new position as much as it is by other methods involving a lateral flexion of the trunk.

The plaster cast is then applied. Windows are immediately cut over the hollow side behind and over the lower ribs, diagonally opposite in front.

FIG. 9. SCOLIOSIS BRACE.

The abdominal pad (H) is of two layers of white chrome leather, with two 18 gauge tempered steels, ½ inch wide, inserted and held by rivets in a vertical position. These prevent the abdominal pad from wrinkling cross-wise.

The U-piece (J) is of 18 gauge steel ½ inch wide, blued and polished and riveted to the side upright (F) and covered with felt and case leather.

The front top bar (K) is of 17 gauge steel ¾ inch wide and not tempered but blued and polished. It is loosely riveted to the top bar to allow it to swing freely, and inserts into a slot of soft steel. Over it is a strap of chrome leather which when buckled holds the front top bar firm in its slot.

When the cast begins to fit loosely, and it soon does so if the breathing exercises are faithfully carried out, felt pads are inserted each week with the instrument shown in figure 7. These pads are forced down between the posterior convexity of the ribs and the cast, just behind the angles of the

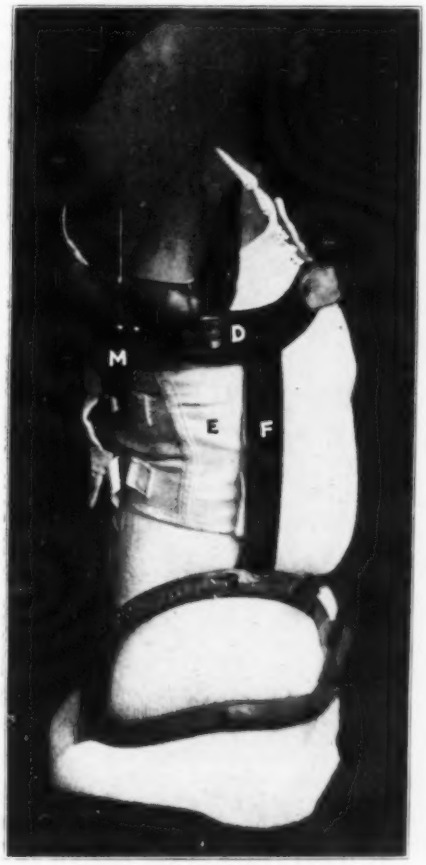


FIG. 10A. SCOLIOSIS BRACE.

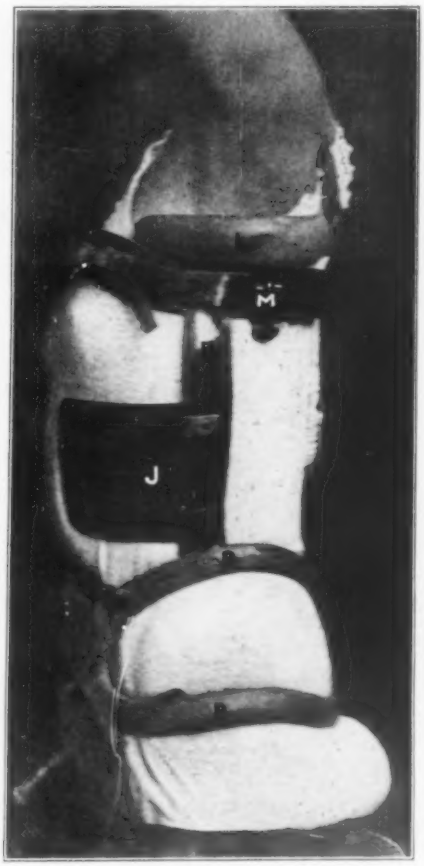


FIG. 10B. SCOLIOSIS BRACE.

The side uprights (F) are of 16 gauge tempered steel, $\frac{5}{8}$ inch wide, blued and polished; and covered on the body side with felt and case leather.

The crutches consist of two parts. The lower part (M) is of 15 gauge steel 1 by 4 inches and not tempered. In this part the holes are drilled for screws with a 19 gauge drill. The upper part (L) is of $\frac{1}{2}$ to $\frac{3}{16}$ inch, thick soft steel, riveted to the lower part and covered with felt and gray sheepskin, except for the outside of the perpendicular side of the crutch where the covering is case leather. The lower part is screwed to the top bar and at this site the top bar (D) is reinforced with soft steel. The holes in the top bar are tapped by hand for $\frac{1}{4}$ inch 8-32 screws.

ribs. This force acting directly on the ribs—at "c," figure 11—tends to increase the advance of the ribs as initiated by the twisting of the patient, and naturally decreases the previous evidence of the rotation deformity, the posterior hump. All this time, from the moment the plaster cast is applied, the patient does formal breathing exercises three times daily. In addition, as noted before, the respiratory force is involuntarily active over twenty thousand times a day. Thus with the trunk warped over so that the alignments of its parts are better balanced about the center of

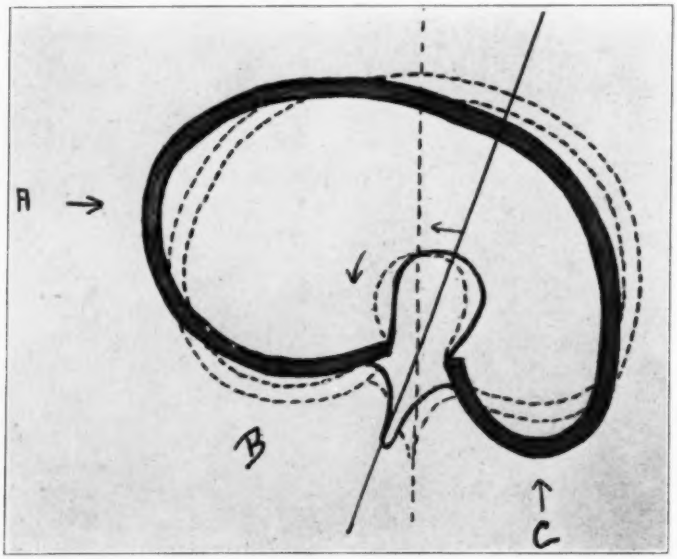


FIG. 11

Diagram illustrating the effect of rotating the shoulder girdle to the right in a patient with a right dorsal, etc. scoliosis.

gravity, there is a palpably evident bulge of the rib wall through the window with each respiration—a powerful correction of the deformity.

The casts are changed about once a month,—that is to say, when they are no longer efficacious. This is continued as long as any improvement follows from these corrective casts. The series is often interrupted by a return to exercises for a time, to return again to corrective plaster jackets. It is often noticeable where improvement in the casts had apparently ceased that, following the break in the series, with the return to the casts another increase in improvement becomes apparent. The patient, while exercising, in between the periods of active correction, wears a plaster jacket similar

to the one applied in the rotated position, but split along the back and front. Leather hinges are then applied to the posterior halves and leather straps and buckles in front. This affords a very cheap retentive apparatus that is also removable.

The leisurely alternating periods of exercising and correction in plaster casts are patiently repeated until finally the maximum amount of correction is obtained. Then "straight jackets" are applied to the patient, lying supine and with his back flattened on the hammock in the Abbott frame. Windows are cut in the cast in the same position as in the "rotated jackets." Felt pads are again forced down between the posterior convexity of the ribs and the cast, and the patient does more breathing exercises. By all this the posterior convexity of the ribs, the hump, is forced still further forward and the advance of that side of the chest progresses by just so much. While this progress is definite, the casts are changed about monthly, —whenever they cannot be made to fit snugly and comfortably with padding. Then finally, when no further gain accrues from the jackets, a plaster model is made of the patient. On this form a brace, as described in figures 8,9,and 10, is built. In the meantime the patient is given a straight jacket similar to the one he has just been wearing, but bivalved and hinged. He also devotes this period to exercises planned to improve his body mechanics. These exercises are continued strenuously and definitely three times a day so as to render the muscular stays of the spine adequate, with the help of the brace, to compensate for any remaining deformity and to retain the more symmetrical improved position of the trunk. Retention is then maintained long enough to give the growing bone, in accordance with Wolff's law of bone transformation, an opportunity to become adapted to the corrected position.

## CONCLUSIONS.

The treatment for structural scoliosis at the Massachusetts General Hospital is a combination of the exercise and corrective plaster jacket methods. We have been led to this because our experience has shown us that these methods used singly have been inefficient. Together, however, they act synergetically, as it were, supplying the complementary parts lacking in each other. Together they render the method of treatment more effective, with the same amount of force, than any form of lateral bending alone in plaster casts.

The pelvis and the thorax are rotated on each other so as to warp the trunk over to the side of the concave deformity. Then the force from the resulting peripheral stresses, augmented first by the respiratory forces

cultivated beforehand by intensive exercise and second by direct pressure on the posterior convexity of the ribs, is relied on for correction of the deformity.

All this seems the natural thing to do in order to straighten a twisted spine. Untwist both ends of the spine in opposite directions while separating these ends, and then force at the center. Then with the breathing in the fenestrated plaster casts the deformed parts, in following the line of least resistance, will advance through the windows to correction.

The method seems to be warranted because it is safe, ambulatory, and causes very little discomfort to the patient. It also separates very effectively the shoulder and pelvis on the concave side of the deformity. But because of the uniformity of the strain from the rotation method the deformation of the thorax, especially on the side made shorter, is much less than with any method which flexes the trunk laterally.

The brace is used to retain any correction obtained while the patient was in the corrective plaster jacket; and since with it, forces can be applied in diagonal directions, the tendency to warp the trunk towards a corrected symmetry, begun in the casts, is usually continued even in the brace.

There has been a great swing of the pendulum toward the operative treatment of structural scoliosis. It is, therefore, timely to show some results of the conservative treatment and to stress the advantages of the method. The procedure throughout is inexpensive, simple, safe, ambulatory, and without discomfort or marked atrophy. It furnishes every opportunity for a more undisturbed growth of the spine, and it leaves the patient at the end of the treatment with better body mechanics and therefore in a better state of nutrition and general health.

## DISCUSSION ON PAPERS OF DRS. LOVETT AND BREWSTER AND KLEIN.

Dr. A. H. Brewster, Boston, Mass.: I have nothing to add to what Dr. Lovett said in our paper except to say that we are applying the same method to mild curves as employed to correct curves between the shoulder blades. This is accomplished by making a posterior shell, which extends from the head to the knees. This cast is cut circularly in two pieces at the point of the apex of the curve to be attacked, and a hinge is placed on the convex side of the curve at its apex. The shell is then mounted on a board and spread apart in the same manner as the jacket here to-day.

The cases, which we hope to report very soon, show a straightening of the curves in this region in a way not obtained by other methods used by us. Whether we are going to be able to hold curves in this region after the apparatus has been removed I am not going to say at present.

Dr. A. Mackenzie Forbes, Montreal, Canada: It has been a great pleasure for me to hear these two papers on the subject of scoliosis, because both of them describe

what, from my point of view, is an attempt to transpose a physiologic scoliosis on a pathologic scoliosis of a reverse order. In other words, I think that both Dr. Lovett and Dr. Klein have adopted what Dr. Adams and I used to call the physiologic treatment of scoliosis. If they have accepted this as the proper treatment for scoliosis, I trust that I may be permitted to congratulate them.

Let me discuss these two papers. The first is that of Dr. Lovett. In the method suggested, Dr. Lovett treats scoliosis by lateralization as opposed to rotation. On the other hand, Dr. Klein attempts to treat by rotation.

It is little more than a decade ago that many of us were intensely interested in the physiology of the spine, spinal movements, and the possibility of making use of our knowledge of these in the treatment of pathologic scoliosis. In those days Dr. Adams and I were accustomed to insist that physiologic scoliosis of exactly the same character followed either rotation or lateralization. Because rotation interfered less with the ordinary habits of the patient, Dr. Adams and I felt that it should be preferred to lateralization. It is interesting to note that Dr. Lovett shows his preference in the method of treatment which he now advocates for lateralization. Dr. Klein, as we have already said, treats by rotation.

May I insist that, from the point of view of the physiologist, both Dr. Lovett and Dr. Klein do exactly the same thing.

Let us study the conclusions given in Dr. Lovett's report of this method of treatment of scoliosis by lateralization.

The Doctor says that he gets a corrective force in a manner believed to be mechanically sound. As a surgeon, I am more interested in physiology than mechanics. I would, then, say that Dr. Lovett, in the method under discussion, obtains a force of a corrective nature which is physiologically sound—that is the force we should aim at. I note that he feels that by lateralization he corrects rotation. This goes without saying. If you correct one you must correct the other, because it is impossible to get one of these movements without the other movement. It is the old principle of Feiss: The thorax moves as a whole—indeed the trunk moves as a whole.

Let us now discuss Dr. Klein's paper. He suggests simply a method of carrying out the treatment suggested by Adams and others more than ten years ago. As Dr. Klein seems to represent the Massachusetts General Hospital, may I not fairly say that it is very nice to feel that this Hospital has been faithful to its old love, because faithfulness in this is so rare. Indeed, may not the average medical man be looked upon as a pendulum, swinging, continually swinging, first to one side and then to the other side? Now, what was the "old love" of the Massachusetts General Hospital? It was to rotate the spine by means of the ribs towards the convexity of the dorsal curve. In those days it was considered that all that was necessary was to fix the pelvis and to rotate the trunk in the direction of the convexity of the dorsal curve. If you study Dr. Klein's method you will see that he has not been satisfied with what Dr. Adams and I considered to be truth. In those days before the war, when we were all so interested in the study of this condition, we felt that it was necessary only to fix the pelvis and rotate the trunk above the pelvis when the pelvis was fixed. Will you consider Dr. Klein's theory in the light of ancient truth?

Dr. Klein has made an interesting statement. He has said that Calvé of Berck has demonstrated the absence of rotation in the lumbar spine. Gentlemen, if Dr. Calvé is reported aright, may I ask whether any one of you agrees with the statement made by him? Does not every one of us know that the lumbar vertebrae rotate and can be

rotated? Do I understand that my friend Dr. Klein suggests that we untwist both ends of the spine in the opposite direction? If I have understood him rightly his conception of the physiology of spinal movement differs very considerably from my conception of this.

I think that Dr. Lovett has been able to prove to you by the pictures which he has shown that he can superimpose a physiologic scoliosis on a pathologic scoliosis of a reverse order. I do not know that he has shown us that he can maintain this correction after the cessation of treatment. This is the important point—the maintenance of that correction which we are able to secure by physiologic methods. It was for this that operative procedures have been suggested. Gentlemen, may I accentuate that I have repeatedly stated that I have not yet learned to believe in the operative treatment of scoliosis except in carefully selected cases; yet it is only fair to say that Whitman of New York, and Hibbs of that same city, have given a much broader definition of the field and advantages of this procedure.

In closing this review of the two methods of treatment submitted, let me repeat that treatment must not be based on mechanical principles, but rather on physiologic principles. The treatment must be physiologic, but for the retention of the correction gained by treatment, we must often depend on mechanical methods.

Dr. Walter Truslow, Brooklyn, N. Y.: It seems to be my fate, whenever the question of lateral curvature comes up before us, to follow Dr. Forbes. You will all recognize the anti-climax. It is a pleasure to follow Dr. Forbes when he does not mention operative treatment, except under his breath. If the Association is swinging back, as I hope it is, toward the realization that a good deal of the treatment of scoliosis is mechanical and with exercise, we are doing something that is extremely wise. These two papers this afternoon in my judgment do not differ in principle.

I would emphasize the principle laid down particularly by Dr. Klein—the principle of proper balance between correction as rapidly as possible and retention of the correction obtained. Dr. Lovett's method is one toward which I have been feeling for several years. I like it and I want to study it.

Dr. Armitage Whitman, New York City: In regard to Dr. Klein's paper, I cannot see that the principles of his treatment differ in any degree from those we have been applying at the Hospital for the Ruptured and Crippled for the past nine to ten years. I am always impressed when I go to Boston with the control that the physicians in Boston exercise over their patients. I think Dr. Klein's principles are sound, and if control over the patient can be exercised, it is splendid. In New York, I am sorry to say, we cannot get a large number of patients to attend the clinic with the same degree of regularity. We cannot get them to come to exercises every other day. I do not know what Dr. Klein's patients do in the summer. We are continually told in the Spring, "Doctor, I cannot wear this jacket, it makes me so hot." If the patients are willing to follow Dr. Klein's jackets and exercises for a period of five or six years, I think it is fine, but in our cases, if they will not continue the treatment, we resort to operation. I might say in passing that we can accomplish by six to eight weeks in the recumbent position on the convex stretcher frame practically all that can be gained by two or three years of corrective jacket that we have thus far seen applied.

From a careful perusal of Dr. Lovett's book I had gained the impression that he stated that the spine was locked in extension. I am therefore interested to see that his jacket is applied in extension, indicating that he has changed his opinion.

I should like to question Dr. Lovett particularly in regard to the case of the high

dorsal curve which he is not attacking. What is he going to do after he gets the correction, and how is he going to maintain the correction through the necessary period of years?

Regarding Dr. Forbes' extreme conservatism I should like to say that we believe also that the classes of scoliosis should be sharply divided. I think that paralytic and so-called idiopathic scoliosis present two entirely different problems, and I would like to ask Dr. Lovett if these were paralytic cases.

In respect to the danger of operation I think Dr. Kleinberg and I together have operated on about seventy cases. I have operated on something over thirty myself, with but one death. Why that occurred, I do not know. It was a rather short operation and the patient left the operating table in good condition, but that night died. Autopsy could not be obtained.

Dr. Armin Klein, Boston, Mass. (Closing his part of the discussion): I just want to answer Dr. Whitman's question, and Dr. Forbes' imputation that we have forsaken old loves and that there is no difference in the treatment we have been using and other forms of the same sort of treatment. That is perhaps true. All I want to say is that we have tried to use the two methods synergetically and not solely alone, as they may have been in the past at the Massachusetts General Hospital.

As to the method of retention during the summer months, we use the jackets applied as I described, but split down the back and front; therefore, a removable jacket which can be taken off for exercise periods during the summer months.

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# FRACTURE OF THE NECK OF THE FEMUR.*

BY JOHN C. WILSON, M.D., LOS ANGELES, CALIFORNIA.

Prior to the past decade, fractures of the neck of the femur were generally considered to be the cause of permanent disability. Unfortunately, this view is still held by many general practitioners of medicine into whose hands, of course, many of these patients fall. This subject has received much scientific discussion during the past forty years. Among the earlier writings, one often reads statements such as, "In persons over sixty years of age who fall and cannot rise, the reason will be found to be fracture of the neck of the femur" (Allis). The same author also states "Bony union cannot be hoped for."

In 1883, Senn published a complete monograph entitled, "Fracture of the neck of the femur with special reference to bony union after intra-capsular fracture." Considerable experimental work was carried out with dogs and cats to ascertain the mode of repair after non-impacted intra-capsular fractures of the neck of the femur. Metallic and bone nails were driven into the femoral neck and the effect on adjacent bony tissue studied.

Senn states that in twenty-one cases in which metallic or bone nails were not used, no union followed, while metallic and bone nails were used in eleven cases with union in two. The inflammation developing around these foreign bodies, leading ultimately to their extrusion, is described as an aid in healing.

The literature of the past ten years is noticeably more abundant in contributions on this subject probably because of disabilities which have been the inevitable result under the old line of treatment.

The monumental contribution of Whitman has served to bring the profession to a realization of the fact that fractures of the femoral neck do not differ greatly from fractures elsewhere, and are at least entitled to the same consideration.

The anatomic construction of the neck of the femur differs from that found in any other place in the body. The neck and shaft join at an oblique angle. Stress of weight-bearing, of course, brings strain on the femoral neck in a plane which is not parallel with its longitudinal axis. Decrease

* Read at the Annual Meeting of the American Orthopedic Association, May, 1924.

in the tensile strength of the neck, such as must be expected in advancing years, renders this bone more prone to fracture than a long bone of the same strength in which the force is exerted parallel to the longitudinal axis.

The attachments of the obturator internus and externus, gluteus medius and minimus, pyriformis, and ilio-psoas, are of importance as factors determining the position of the distal fragment. The capsule of the hip joint may become interposed, because of its relation to the neck, between the fragments, and produce non-union.

It is not the purpose of the writer to consider pathologic fractures, so trauma and undue muscular force must be considered the sole causative factors.

Any classification of these fractures into groups other than linear, complete or incomplete, and comminuted, is misleading. The terms extra-capsular and intra-capsular are inaccurate. Describing a fracture as through the neck of the femur clearly limits its anatomic bounds.

The question of impaction calls for greater consideration. Undoubtedly impacted fractures of the femoral neck do occur, but much less frequently than was formerly supposed. The advent of the stereoscopic roentgenogram has thrown much light on the subject. Careful study with the stereoscope will often reveal anterior rotation of the distal fragment with posterior displacement of the proximal one in such a way that locking takes place. This locking of the fragments may be secure enough to allow considerable manipulation of the leg without discomfort to the patient, leading the examiner to believe that an impacted fracture is being dealt with. It will readily be seen that there can be no contact of the fractured surfaces in such a case, and non-union is certain to result if the fragments are left in this relation. A flat roentgenogram will demonstrate what has ordinarily been considered an impacted fracture.

The physical signs are not as important now as they were before the X-ray was so generally used. The fall followed by disability, pain, eversion of the foot, and shortening of the leg, with spasm of the muscles around the hip are too familiar to require further comment. Stereoscopic roentgenograms should be taken in all cases of suspected injury about the hip, because it is never safe to eliminate fractures upon the basis of physical findings alone. Disability following hip fractures is often trivial immediately after the injury and is too frequently considered to be only a sprain which a few days rest in bed will alleviate.

Treatment of the recent fracture may be described in one word: reduction. In some instances, fracture of the neck of the femur is a terminal affection. The frail elderly woman suffering from cardio-vascular

disease who becomes delirious and involuntary within a day or two following the injury and who dies during the first ten to twelve days is too well known. In such cases, the folly of reduction is obvious. Surgical judgment is just as essential in these cases and perhaps more so than in the management of any fracture. Practically all recent authors, with the possible exception of Ridlon, are of the opinion that reduction should be attempted and maintained. Ridlon reports forty-one cases which he states had no treatment or worse than no treatment. Of these forty-one cases, thirty-five were in adults. Twenty-one, or slightly more than fifty per cent., were able to walk without a cane. It is the opinion of the author that this percentage of recoveries is too low and can in no way be used as a justification for no treatment or worse than no treatment. Ridlon also states that the type of union is not essential if function is good, with which all practical surgeons will concur. Ruth has advocated for many years combined lateral and longitudinal traction as a means of maintaining reduction. This requires constant observation on the part of the surgeon and, in the hands of some, is undoubtedly an excellent method. However, as a general measure, it cannot be recommended.

Kemp has devised an abduction splint which he states maintains alignment and allows more freedom to the patient, with earlier locomotion.

Jones advocates a splint devised by Buckner, consisting of a combination of a Taylor back brace and a Thomas leg splint connected by adjustable angle irons which will allow any degree of abduction. This seems to be a practical appliance, and in the proper hands should give satisfaction.

The abduction treatment devised by Whitman is undoubtedly the most satisfactory method known at present of securing and maintaining anatomic reposition of the fragments after fracture of the neck of the femur. Plaster of Paris properly applied is not only comfortable to the patient but is certain to maintain reduction.

Whitman describes his method of reduction and fixation as follows:

"The extended limb on the sound side is abducted to the normal limit to demonstrate the normal range and to fix the pelvis. That on the injured side is then, under traction, slowly abducted and rotated inward, the surgeon supporting the joint with his hands and pressing the trochanter gently downward. The limitation of abduction, caused by contact of the deformed neck with the upper border of the acetabulum, is recognized, but it is easily overcome. When the limit of normal abduction is reached it may be inferred that the proper relation between the neck and shaft of the femur has been restored. The limb in this attitude of complete extension, abduction, and slight inward rotation is then securely fixed by

a long plaster spica. It may be noted that this method of reducing the deformity by abduction followed by the immediate application of support hardly corresponds to what is known as the 'breaking up of an impaction.' Far from endangering union, it should favor it by actually apposing the fractured surface.

"If the fracture is complete the same treatment is adopted with the following modification. The patient lying in the position described, the disabled member is first flexed to disengage folds of capsule that may have fallen between the fragments. It is then extended and rotated inward to the normal attitude, and under traction and counter-traction the shortening is completely overcome, as demonstrated by measurement. The sound limb is then abducted to the limit to demonstrate the normal individual range and to fix the pelvis. The limb on the injured side is then slowly abducted by the assistant, while the surgeon supporting the joint pushes the thigh upward from beneath to force the two fragments against the anterior part of the capsule. When the limit of abduction has been reached the capsule will be tense, thus directing the fragments, now in a horizontal plane and end-to-end, toward one another and finally forcing the contact. If the fracture is near the head, the outer fragment may be inserted beneath the acetabular rim. If at the base, the trochanter under ordinary conditions will be apposed to the side of the pelvis, thus preventing upward displacement."

One should not be satisfied after reduction, according to the technique described by Whitman, without the careful study of stereoscopic roentgenograms of the hip made through the plaster.

After this reduction, the fractured surfaces may not be properly apposed. At times, the base of the proximal fragment will be found to have rotated upward into a position which allows only marginal contact of the fragments. If such be the case, the cast should be removed and reduction again attempted. One should not be satisfied until stereoscopic roentgenograms following reduction show good anatomic reposition. More than a second attempt is rarely necessary and it is only infrequently that satisfactory alignment is not obtained after the first reduction.

This would seem to be the most important single factor in the management of these cases. Roentgenograms of fractures of long bones are taken many times and much care is exercised to secure a good alignment, but fractures of the neck of the femur have been put in plaster without further roentgenologic study of the alignment. Careful examination of roentgenograms after reduction by the Whitman method has shown that perfect apposition is not always obtained. The proximal fragment has been

displaced upward, due to rotations of the head. Non-union is inevitable if the fragments are allowed to remain in such a position, a factor to be considered in non-union following treatment by the Whitman method.

Henderson reports one hundred and twenty cases of ununited fracture of the neck of the femur, in which he states that poor treatment is the greatest single causative factor. Poor treatment means poor reduction; consequently there was no possibility of union even though osteogenesis could take place at the site of fracture.

Careful dissection, by the writer, during operation in nine cases of ununited fracture of the neck of the femur showed interposition of the capsule in eight. In five of these cases, the capsule was adherent to the anteverted raw surface of the distal fragment. In two cases, the capsule was densely bound to the distal portion of the proximal fragment. In the remaining patient, the capsule had become constricted between the fragments in a manner similar to the hour glass constriction seen in the congenital dislocation of the hip. From three to twenty-seven months had elapsed since the injury in these cases. This emphasizes the necessity of early reduction before the capsule has had sufficient time to become firmly adherent. No closed manipulation could possibly free any of these fractured surfaces to which the capsule was adherent. It was only after careful and difficult dissection that these bone ends were entirely denuded.

No conclusive data concerning the blood supply of the head of the femur is available. It is probable that the importance of this factor as a cause of non-union has been overestimated.

Kleinberg reports three cases which were reduced by the Whitman procedure; one, four and five months following the injury. Good function resulted in each of these cases. Realizing the rapidity with which fibrous tissue proliferation may take place around fractured bony surfaces that are not in contact, and considering the particular danger of soft tissue interposition, it must be conceded that these cases are to be considered as exceptions rather than the general rule.

A number of operative measures have been advocated to secure function in ununited fractures of the femoral neck. Some are constructive, such as that advocated by Brackett and the bone grafts of Henderson and Albee. Others are essentially destructive, namely the so-called reconstructive operations of Albee and Whitman.

One is often astonished upon opening up an old fracture of the femoral neck in which the roentgenogram has shown extensive absorption of the neck to find that a considerable portion remains.

Probably one of the first open reductions of such a fracture was

recorded by Professor Loreta in 1888. The fracture was nineteen months old, in a patient thirty-six years of age. The fracture line was exposed, the fibrous tissue removed, and a bundle of metallic sutures inserted between the bone ends. These were removed on the fifth day. Good union followed and the patient left the hospital in fifty-five days, walking without pain.

In case the neck has not been markedly absorbed, open reduction should be the operation of choice. This represents an attempt to restore the structures as nearly as possible to their normal anatomic state. The capsule of the hip joint is easily exposed by a slight continuation downward of the Smith-Petersen incision. Capsule and other soft tissue is removed from the fragments. The bone ends are scarified and complete abduction and internal rotation of the leg will bring them into perfect anatomic position. A plaster spica is applied and the condition is identical with that at the time of fracture, except perhaps for some shortening of the neck made necessary by refreshening the bone ends. This operation has been found very satisfactory by the writer in a small number of cases. It is logical and sane and is entitled to more general consideration.

The use of autogenous grafts in the form of dowel pegs or a section of the fibula to fix the fragments and promote osteogenesis, has been advocated chiefly by Albee and Henderson. Fixation in plaster for a period of three months is required for consolidation of the fragments and graft.

Out of fifteen patients subjected to bone grafting operations, Henderson reports nine good results. It is difficult to see how the presence of soft tissue between the fragments can be obviated unless the joint is opened and the bone ends are inspected. The blind introduction of the bone graft into the neck does not take this into consideration. It is also a well known fact that unreduced fragments in fractures of several months' duration will not unite even though brought into apposition, unless they are refreshened. However, this operation has proven very successful in the experience of some surgeons, Campbell having reported eleven successful results out of fifteen operations.

Brackett's operation is similar in some respects to the open reduction. The hip joint is exposed by the antero-lateral three limbed incision and the tip of the great trochanter is removed at the level of the neck. The inner surface of the upper extremity of the shaft which has been refreshened by removal of a part of the trochanter is contoured in such a way that the remnant of the neck with this reshaped part of the shaft fits accurately into the scarified concavity of the femoral head. It may readily be seen

that in this way the head does not rest directly on the femoral shaft as illustrated by Whitman in his description of Brackett's operation for ununited fracture of the neck of the femur. The argument put forth that adduction of the leg will cause dislocation of the head is purely didactic and lacks practicability. The shortening which follows Brackett's operation allows a tilt of the pelvis toward the affected side, which serves to increase the range of both adduction and abduction.

If there has been no weight-bearing on the affected side for some months, osteoporosis will be pronounced. The head may be so soft that it can be crushed with forceps. It has been of great interest to the writer to watch the rapidity with which the fragments unite and to see the increase in density, by roentgenogram, after they are placed in apposition. The convalescence of these patients after Brackett's operation may be compared to that of a fresh fracture, except for the shock of operation.

Arthritis of the hip joint is a contra-indication to this operation because of the persistent stiffness and pain which follows the long immobilization.

Dr. Brackett reports only one good functional result out of twenty-four cases subjected to this operation. This must be considered an extremely conservative report and in no way derogatory to this operation, as many of these cases were undoubtedly much improved.

Reconstruction, or rather, operations which destroy entirely the possibility of anatomic restoration in favor of function, have been described by both Albee and Whitman. They are similar, having as their principal object the replacement of the femoral head by the neck of the femur, which is placed in the acetabulum.

Albee does a splitting of the great trochanter outward with its muscular attachments after it has been partly cut through from above downward with a thin-bladed chisel. Whitman removes the trochanter with its attached muscles and sutures it to the denuded femur below the point of its normal attachment.

Shortening and some restriction of motion at the hip are inevitable. Convalescence of the patient is shortened and good functional recoveries are reported by both writers.

Persistent pain, one of the most trying of symptoms to persons suffering from ununited fracture of the femoral neck, is due almost entirely to rubbing together of the fragments. In the case of those not suited to some of the procedures requiring a prolonged convalescence, simple excision of the femoral head may be advisable. This is a simple operation through

the posterior route if the patient is thin. The anterior approach is preferable if the patient is covered by a thick layer of fat. Movement is begun the day following operation and the patient is up and about on crutches as soon as the wound is healed. Some impairment of function is to be expected, but relief of pain is certain.

All of these operations have their indications, but as ever in surgery, their selection is a matter of judgment. If all of the structures are present, namely a fair neck and the head, it seems that they should be utilized, as any appreciable anatomic alteration is certain to cause impaired function.

Stiffness in the knee and hip joint follows the long period of immobilization. Stiffness in the knee, particularly, is painful and of great concern to the patient. Various types of metallic joints have been suggested for incorporation in the cast to allow flexion at the knee.

Stiffness in the hip joint is always present, often causing discomfort while sitting for a long time after the plaster has been removed. This is more pronounced in those cases that have been subjected to surgical interference.

Physiotherapy is a valuable adjunct to the convalescence of the patient. Early restoration of muscle tone and re-establishment of circulation aid in recovery. The knee may be subjected to vigorous treatment to secure movement as early as possible, while the hip must be handled gently for at least six months, or until the fragments are firmly united.

A person with an immediate fracture of the neck of the femur has a splendid chance for recovery if proper reduction is obtained soon after injury. The patient with an ununited fracture of the femoral neck faces an entirely different situation. There is no procedure known at present which will give a good functional recovery in the large proportion of these cases.

## CONCLUSIONS.

1. Fractures of the neck of the femur will, as a general rule, unite, providing there has been a good anatomic reduction.

2. True impactions of fractures of the femoral neck occur rather infrequently.

3. Improper reductions, and interposition of the hip joint capsule, are the principal causes of non-union.

4. The surgical treatment of ununited fractures of the femoral neck should preserve if possible the anatomic structures.

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# A CLINICAL STUDY OF UNUNITED FRACTURES WITH SPECIAL REFERENCE TO THE INORGANIC BONE-FORMING ELEMENTS IN THE BLOOD SERUM.*

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Non-union of fractures has for a long time been one of the most interesting and obscure problems in surgery. A tremendous literature has been written, and yet there is still little unanimity of opinion regarding causative factors and modes of therapy.

According to Stimson[1] failure of union is perhaps more common in the shaft of the humerus than in any other bone, with the possible exceptions of the radius and ulna. Delayed union is most common in the long bones and is much more frequently found associated with compound than with simple fractures.

Comparatively little agreement exists as to the underlying factors responsible for failure of union. An enumeration of the various causes which have been held to play a part in non-union would be almost interminable. Groves[2] stressed particularly the displacement of fragments with fibrous tissue intervention. He also mentions necrosis and sclerosis as probable etiologic factors. In partial accord with him are Waring and Milligan,[3] Beresford,[4] Bloch,[5] Nutter,[6] Potts,[7] and Jones.[8] Others have emphasized constitutional disorders, more especially syphilis, tuberculosis, malaria, and the acute infections. Stimson cites pregnancy, lactation, and defective nourishment as factors in some cases. Estes[9] ascribed to nervous diseases, old age, and starvation a particular importance in causation. Defective blood supply as a causative factor is found in the literature almost as constantly as faulty apposition.

From this brief summary, it is apparent how diverse is the opinion relative to the factors responsible for non-union. In general, most observers have held local causes to be of primal importance, and have given little credence to the views of the few who have attempted to put forth some constitutional disorder as a basis. It is quite probable that one or

* Read at the Annual Meeting of the American Orthopedic Association, May, 1924.

all of the above mentioned causes may be responsible for non-union in some instances.

In the treatment of non-union Geist,[10] Larkin,[11] Hoy,[12] and others have mentioned the use of calcium carbonate, calcium lacto-phosphate and sodium phosphate with beneficial results. Phemister[13] has emphasized particularly the value of yellow phosphorus in the treatment of these cases. It seems that these important observations have never been given sufficient consideration.

The treatment of non-union suggested by most observers, including Potts, Buchanan,[14] Henderson,[15] Robertson,[16] Meyers,[17] Campbell,[18] Nutter, and others, has consisted in the main of local therapy; immobilization followed by massage, baking, and other procedures calculated to produce a local hyperemia of the part affected. Immobilization is usually obtained by fixation in plaster or splints. If a more radical procedure is indicated, the fragments are brought into apposition and held in place by mechanical fixation with either wire, bone or metal plates, or bone graft. Massive bone graft has, it seems in most instances, given the best chance for cure. Several observers, notably Willard,[19] and Hoy, already referred to, emphasize the importance of partial immobilization of the limb in the hope that the mechanical irritation thus afforded would stimulate osteogenesis. In addition to these methods of therapy, others have employed thyroid and pituitary extracts, with questionable benefit.

The treatment, then, for the most part has been limited to local procedures, with little prominence given to a possible constitutional factor. With this wide diversity of opinion regarding causation and modes of therapy, it seemed that further study would not only be of clinical interest but also capable of contributing to the knowledge of causation, of which no one will gainsay the obscurity.

The simplest type of bone repair is seen after fracture. The various stages concerned in the process, borne out by the experiments of Bancroft[20] and others, are as follows: Immediately after fracture there is abundant hemorrhage between the fragments. Fibrin formation and contraction of the clot then occurs. Next there is an ingrowth of connective tissue and the pushing in of small blood vessels. Following the penetration of the blood vessels, two distinct and opposite processes begin, on the one hand the rebuilding with live bone, and on the other an absorption and clearing away of the fragment, the one task assigned by some observers to osteoblasts, the other attributed to osteoclasts.

In general, three theories have been advanced as to the formation of bone. According to one, the metablastic theory, the members of the

connective tissue group, fibroblasts, through stimulus of growth or repair are given inherent power of transformation into specific bone-producing cells. This theory has been largely abandoned and replaced in a measure by the osteoblastic theory. This idea assumes the existence of the osteoblast, a specific cell, which is the active agent in bone formation. Regarding its derivation nothing definite is known. Moschowitz[21] believed it to be simply a differentiated endothelial cell from the wall of the blood vessel. The weight of evidence is at present in favor of a third view, especially supported by the work of Barille,[22] and of Wells.[23] This theory assumes that there is no definite bone-producing cell, but that a complex salt, calcium carbono-phosphate, carried as such in the blood, is precipitated in the bony matrix by a change in the carbon dioxid content of the tissue, and after deposition is finally converted into two components, calcium carbonate and tertiary calcium phosphate. Wells believes that calcium phosphate and calcium carbonate are present in the ash of calcified material, such as kidney and arteriosclerotic plaques in the same proportion as in bone; the main difference being that calcification occurs in dead tissue, whereas ossification takes place in living tissue.

An exact knowledge of the way in which bone salts are added would indeed be a great aid to our understanding of bone repair. However, here we are not so much concerned with the manner in which these salts are laid down, as we are in the deficiency of these bone-forming elements, and the factors responsible for their lack.

The experiments of McCollum, Simmonds, Shipley and Park,[24] have shown that the production of rickets in animals may depend upon three dietary factors, the concentration of calcium, that of phosphorus, and the amount of anti-rachitic vitamin as represented by cod-liver oil. The same investigators, as well as Hess[25] and others, have shown that sunlight, either natural or artificial, may be substituted as the anti-rachitic factor. When the amount of anti-rachitic vitamin or radiation is adequate, both animals and children are protected from rickets even in the presence of a gross deficiency of or disproportion between calcium and phosphorus, in the diet. The value of sunlight or the radiations from the mercury vapor quartz lamp for the treatment of rickets is now firmly established.

Howland and Kramer[26] in their study of the disease have pointed out that the blood of patients with active rickets shows a reduction of the calcium or phosphorus, or of both elements of the serum; so that the calcium and the phosphorus product (the calcium in milligrams per 100 cc. serum times the phosphorus in milligrams per 100 cc.) is usually less than thirty. In the healing of rickets they have noted that no healing takes

place with a product below thirty and that little healing will take place until the product is between thirty-five and forty. Tisdall and Harris[27], in a study of the calcium and phosphorus of normal healing fractures, have found the adult's calcium to be 10 milligrams per 100 cc. and the phosphorus to be 3.8 per 100 cc.

The present study of ununited fractures was begun in the Hunterian Laboratory and in the Orthopedic Dispensary of the Johns Hopkins Hospital early in September, 1923. It was suggested partially by the work of Nutter, who noted that non-union was especially common after osteotomy for bow legs. Other writers have made similar observations. Bow legs being generally of rachitic origin, the question presented itself as to whether non-union might not have a kindred relationship to rickets, with some disturbance of the calcium and phosphorus ratio underlying it. A study of the radiograms of thirty rachitic children in whom single or multiple fractures occurred as a complication revealed the fact that when the bones showed a healing of the rachitic condition the co-existing fractures also showed healing. No healing of the fracture was observed until the rachitic manifestations showed improvement. These observations, coupled with the apparently efficacious use of calcium, either as carbonate or phosphate, mentioned by Geist, Larkin, and Hoy, together with the therapeutic value of yellow phosphorus in the hands of Phemister, gave support to such an idea, and made such a query plausible.

A search through the literature reveals no report of a similar study. (Tisdall and Harris, in their study of calcium and phosphorus in the healing of normal fractures, include two cases of non-union.) (Pincus [data unpublished] notes findings in several cases of non-union to agree with my own.)

It was decided to study the calcium and phosphorus content in the blood serum of patients presenting non-union and, at the same time, to study the blood of a group of presumably normal patients with fractures, these being used as controls.

Since the first of September, 1923, seventeen cases of ununited fracture have come under observation. Eleven of these presented deficiencies in either the calcium or phosphorus content of the serum, showing low calcium and phosphorus products. In six the blood findings were normal. A summary of nine cases in which the studies are completed is given below. These patients were seen in the Orthopaedic Dispensary of the Johns Hopkins Hospital, the Mercy Hospital, the Union Memorial Hospital, the Church Home and Infirmary, and the Children's Hospital School.

## SUMMARY OF CASES.

CASE 1. D. L. Male; white; aged 47.
DIAGNOSIS: Non-union of radius and ulna.

On July 19, 1921, the patient was struck a glancing blow on the right wrist by a swinging steel railroad tie. A roentgenogram was taken and the arm put up in a splint. On August 22, 1921, the splint was removed; no union had taken place. On January 16, 1922, an open reduction was performed and fragments were wired; this did not result in union. On July 24, 1922, another operation was performed. This time a Lane plate was used. Infection followed and the plate had to be removed. On December 11, 1922, the patient had a third operation, and on March 23, 1923, another unsuccessful attempt was made for union. The patient came to the Johns Hopkins Hospital in November, 1923, for further study.

The patient was operated upon on November 7th. The ends of the fragments were freshened and wired in position. The calcium and phosphorus was found to be 10.8 and 2.25 respectively. The patient was placed on a high protein diet with calves' liver three times a week; calcium carbonate, grams two; cod-liver oil, ounces one; buttermilk, five hundred cc.; orange juice daily. No union took place during the first six weeks following operation. During this period the product of the inorganic constituents, calcium and phosphorus, remained below thirty. With this diet the phosphorus gradually increased. On January 2, the calcium was 10.3, the phosphorus 3.75 and the product 38.1. It was thought that the mercury quartz lamp might raise the phosphorus still further, so fifteen minute exposures daily were substituted for cod-liver oil. On February 18, the calcium was 10.4, the phosphorus 4, and the product 41.6. On May 1, radius had united, ulna was uniting.

Since in this case and in some of those summarized below, dietary therapy, followed or preceded operative procedure, the query might well be raised, is the union not the result of operative rather than dietary therapy? This case does not support such a view, since, after repeated attempts, no union had resulted; neither did union follow the fifth operation until dietary procedures had had their effect.

CASE 2. J. E. Male; white; aged 23.
DIAGNOSIS: Non-union of radius.

Radius of the left forearm broken in March, 1918. Since then this patient has been operated upon twice, in each instance by a thoroughly competent surgeon. Wire was used in the first operation and a bone graft was used in the second. Both operations were unsuccessful from the standpoint of union. On November 6, 1923, the patient was admitted to the Church Home. Operation was performed November 6; a diamond graft was inserted, held in place by a kangaroo tendon, and the arm put up in a plaster cast. On admission to the hospital the patient's calcium was 9.5 milligrams per one hundred c.c. serum; phosphorus 2.55; resultant product 24.25. The patient was placed on the same diet as Case 1. On November 26, the calcium was 9.58; phosphorus 4.1; product 39.27. Patient discharged November 27, with union taking place. December 17, the calcium was 10; the phosphorus 3.9; product 39. Radius united.

CASE 3. H. M. Female; white; aged 10.
DIAGNOSIS: Non-union of tibia and fibula, left.

When patient was three months old the foot was accidentally struck by an older sister and the bones of the left leg were broken. Nothing was done until about the age of four, when she was brought to Baltimore and given a brace to wear. The patient wore the brace for three years and then discarded it for crutches. Physical examination on admission showed the left leg to be 9 cm. shorter than the right. There was disuse atrophy of the thigh and calf muscles, and no union of tibia and fibula.

The patient was operated on April 25, 1923, open lengthening of Achilles tendon; open reduction ununited fracture tibia and fibula (left); plate in tibia and fibula wired. Infection followed, and after treatment with Dakin's solution had failed, the plate was removed July, 1923. In October a sequestrectomy and curettage of tibia was done. On November 12, blood chemical analysis showed the calcium to be 10.3 and phosphorus 2.6. The patient placed on diet as in Case 1. January 4, the calcium was 10.1, and phosphorus 3.8. The patient is still draining, though less in amount. No union has yet taken place.

The failure in this case we assume to be the result of the concomitant osteomyelitis. It is difficult to conceive of the probability of solid bone formation in an area where active destruction is taking place. The case is included in order to emphasize the need of constitutional as well as local procedures.

CASE 4. J. W. Male; white; aged 42.
DIAGNOSIS: Non-union of ulna and radius.

In September, 1921, the patient had his right arm caught in a machine, which resulted in compound fracture of both bones of the forearm: An attempt at reduction was followed by infection, which was treated by the method of Dakin. In May, 1922, the radius was wired with no beneficial result. In August, 1922, a bone peg taken from the tibia was grafted to the radius; no union followed this operation. On May 15, 1923, the radius was again grafted and the ulna plated. No union followed this operation. The patient was discharged June 15. The patient was referred to us on November 19. The calcium at that time was 9.5; the phosphorus 2.4; the product 22.8. The patient was placed on a similar diet to Case 1. Calcium and phosphorus determinations were done weekly. In this case the raising of the calcium and phosphorus has been a very slow procedure. On December 17, one month after diet was commenced, the product is only 33.9. The phosphorus has been raised from 2.4 to 3.2. On February 15, the calcium was 10.3 and the phosphorus 3.1. On March 17, the calcium was 10.3 and the phosphorus 3.8. There has been gradual improvement in the condition of the arm, ulna united, radius uniting.

CASE 5. B. T. Male; white; aged 18.
DIAGNOSIS: Fractured femur, left.

The patient was struck by an automobile on July 17, 1923, which resulted in fracture of left femur. The leg was put in traction for a week, followed by cast for two weeks; this cast was then taken off and replaced by another for eight weeks. Union was not firm at that time, so a third cast was applied; this remained on for six weeks. The

patient was then able to walk, but after a week a bulging appeared over site of fracture. On November 3, a plate was used to hold the bones in place and a cast applied, which has remained on to time of admission. Special note by Dr. V. D., November 30, 1923: The patient came to the hospital because of difficulty in obtaining union in a fracture of his left humerus, which fracture occurred four months ago. The fracture was treated for one week in traction and thereafter by casts. There was difficulty in obtaining proper apposition of the bones, so that mal- or non-union existed. Three weeks ago the fracture was plated; after plating, the radiogram showed a marked bowing and the plate itself had broken. The patient then came to Baltimore. The patient is wearing a plaster spica on the left leg which goes to the ankle, the foot itself being out of the cast and in extreme external rotation. The cast was removed and the leg lay in a position of extreme external rotation, the patella pointing lateralward. There is an angulation at the mid-shaft region, bowing outward of about 30 degrees. The leg seems to be fairly stable, and, while one is unable to feel definite callus, one gets the impression that the bones are pretty well glued together. Manipulation fails to produce any crepitus. The lateral position of the fracture is good. Impression: Fracture, shaft, left femur, old.

Repeated calcium and phosphorus determinations on this patient show a calcium of 10.5 and phosphorus 4.1. It is highly probable that here the condition is mal-union rather than non-union. At the time of discharge roentgenogram shows fragments in good apposition; plate is broken and there is good callus formation. The patient was not treated, since what had been done was considered adequate.

Case 6. R. D. Male; white; aged 7.
Diagnosis: Non-union of tibia, right.

At the age of two and one-half years (1919) the patient fractured the lower right leg, the result of a fall. No union took place after a long period of immobilization. In January, 1921, a graft was taken from the left tibia and inserted into right. A radiogram in August, 1921, showed no union. The patient has been wearing a cast during the interval between last operation and admission, nearly three years. General physical examination is negative save for local condition. There is preternatural mobility at site of fracture. No pain is elicited on movement. The patient showed the following blood chemical analysis on admission December 7, 1923: calcium 8.4, phosphorus 4.7. The patient was placed on diet, and blood calcium raised before operation. December 14, 1923: calcium 8.8, phosphorus 4.3. December 29, 1923: calcium 9.2, phosphorus not done. January 16, 1924: calcium, 9.9, phosphorus 4.7. The patient was operated on January 17, 1924, a large graft being inserted between fragments. Diet continued after operation. Patient discharged February 25; union has taken place.

Case 7. I. M. Male; white; aged 35.
Diagnosis: Non-union of right radius.

In 1914 the patient was kicked by a horse, breaking the right radius. The fracture was reduced at the Mercy Hospital. Two days later a metal plate was put in, since fragments would not remain in place. No union resulted, but the patient was able to use arm until August, 1923, when the metal plate broke. The patient went to Mercy Hospital. A bone graft was then taken from tibia and inserted into radius in attempt to secure union. The patient remained in cast until December. No union resulted. Blood chemistry on December 7: calcium 8.1, phosphorus 3.25, and the product 23.3.

The patient placed on diet. February 8: calcium 10.7, phosphorus 3.5. The patient was operated upon February 18. Graft taken from tibia and placed in radius. March 15: union has taken place.

CASE 8. C. P. Male; white; aged 30.
DIAGNOSIS: Non-union of left humerus.

The patient was in an automobile accident May 6, 1923, at which time he sustained a simple fracture of the left humerus. Open reduction was performed May 7, and the bone plated. Two weeks later radiograms showed one end of plate to be loose and fragments separated. Operation again resorted to, plate removed, and arm put up in plaster. The patient wore this for two months. There has never been any union since the first operation, May 7, 1923. The patient's blood serum showed the following calcium and phosphorus content on January 2: calcium 9.7, phosphorus 2.6. The patient placed on the following: calcium carbonate, two grams; yellow phosphorus, one one-hundredth grain, twice daily; cod-liver oil, ounces one; in addition to buttermilk, five hundred cc. orange juice, and a high protein diet. On January 7, the patient was again operated on, a graft being taken from tibia and inserted into humerus. On January 21, after nineteen days on diet, the calcium was 9.92, phosphorus 3.95, and the product 39.1. Healing was uneventful, and patient was discharged well, February 23.

CASE 9. J. C. Male; white; aged 34.
DIAGNOSIS: Fracture tibia and fibula, left, compound comminuted. Non-union tibia and fibula.

On October 23, the patient, while at work on a tug, became entangled in a rope and was thrown overboard, his left leg being broken in the accident. He was picked up and immediately taken to the Johns Hopkins Hosiptal. On examination it was found that the patient had received a compound fracture of both bones of the left lower leg. After as thorough disinfection of the laceration as possible, the fracture was reduced under gas-oxygen anaesthesia, and the leg put up in plaster. Radiographic examination showed fragments in good position. The patient remained in hospital three days for observation. After discharge the patient returned weekly to the dispensary for examination. After seven weeks there was no solid union of fragments. His blood chemical analysis made on December 14 showed a calcium of 10.1 and a phosphorus of 3.1. The patient was placed on a diet high in phosphorus, and on January 7, the calcium was 9.4 and the phosphorus 4.0. January 18, the calcium was 9.5 and the phosphorus 4.1. February 11, the calcium was 9.7, and the phosphorus 3.8. Since dietary therapy there has been increasing solidarity of the part, shown radiographically and also by manual examination. There is no false motion; union has taken place.

This case is of special importance since no operation was performed, union following dietary therapy alone.

It might well be worth while to consider briefly these cases as a group.

Regarding locus, non-union of both bones of the forearm occurred twice; the radius alone was the site also in two; in one case the humerus was the bone involved. In the leg, the fibula and tibia were ununited in two instances; non-union of the tibia and femur each occurred once.

The age of these patients varied from seven to forty-seven years. Two were in the first decade, one in the second, two in the third, two in the fourth, and two in the fifth.

In every instance save one, these patients had been previously operated upon for the existing non-union. The total number of operations in these eight cases was twenty-two, or an average number in each case of slightly less than three.

Regarding operative procedures, as will be noted in the summaries of these cases, it would seem that a fair test had been given every method of treatment, including wiring, plating, and grafting of fragments.

Faulty apposition of fragments with interposition of soft parts, the most frequent causes assigned to non-union, certainly could be ruled out in these cases as a cause of failure to unite, since the fragments were brought into and held in apposition by operation.

Infection as a primal factor must be considered, since, in the course of surgical procedure, it had followed three operations. However, at the time these cases were presented for study, infection was present in only one instance, and save in this one patient, could not be ascribed as a causal factor for non-union.

Lues, so frequently referred to as being responsible for non-union, was not present in a single instance.

In view of the employment in several instances of wire and steel plates, one may ask, were they not in a measure responsible for non-union? Certain it seems that the use of these bodies was not followed by remarkable success, but even in their absence no union resulted, and in the case of D. L., (Case 1), wire did not hinder union, once the calcium and phosphorus of the serum was adequate. Plating or wiring does undoubtedly delay union, but in the absence of other factors union will as a rule result. In a word, the local treatment, save in the case of H. M., (Case 3), complicated by infection, would seem to have been adequate.

The calcium and phosphorus content of the blood serum of these patients was determined; the calcium by the method of Kramer and Tisdall,[28] which method was accurate to within three per cent. on standard solutions; the phosphorus by the Briggs[29] modification of the Bell-Doisy phosphate method. The calcium and phosphorus determinations and the calcium and phosphorus product in these nine cases are shown in the accompanying tables. The findings in the presence of non-union are given in Table 1. The calcium and phosphorus content of the serum when union has taken place, is seen in Table 2.

TABLE 1.

| | *Calcium Mgms. per 100 c.c. serum* | *Phosphorus Mgms. per 100 c.c. serum* | *Product* |
|---|---|---|---|
| D. L. | 10.8 | 2.2 | 24.3 |
| J. E. | 9.5 | 2.5 | 24.2 |
| H. M. | 10.3 | 2.6 | 26.8 |
| J. W. | 9.5 | 2.4 | 22.8 |
| R. T. | 10.5 | 4.1 | 43.0 |
| R. D. | 8.4 | 4.3 | 36.1 |
| I. M. | 8.1 | 3.2 | 26.3 |
| C. P. | 9.7 | 2.6 | 25.2 |
| J. C. | 10.1 | 3.1 | 31.3 |

TABLE 2.

| | *Calcium* | *Phosphorus* | *Product* |
|---|---|---|---|
| D. L. | 10.4 | 4. | 41.6 |
| J. E. | 10. | 3.9 | 39.0 |
| H. M. | 10.1 | 3.8 | 38.3 |
| J. W. | 10.3 | 3.8 | 39.1 |
| B. T. | 10.5 | 4.1 | 43.0 |
| R. D. | 9.9 | 4.7 | 46.5 |
| I. M. | 10.7 | 3.5 | 37.4 |
| C. P. | 9.9 | 3.9 | 38.6 |
| J. C. | 9.7 | 3.8 | 36.8 |

These results are extremely striking and acquire special significance when compared with the calcium and phosphorus findings in nine presumably normal patients with fractures, shown in Table 3.

In six of the non-union cases the calcium is practically a normal figure. The phosphorus, however, is low. Two patients present a low calcium figure with a normal, or slightly decreased, phosphorus. In one patient, a young boy, (Case 5), B. T., the product and amount of each constituent was normal. What the underlying factor is in this case remains undetermined. An examination note states that the fragments were "fairly well glued together." In all probability here the condition is mal-union, rather than non-union, and perhaps this individual should not have been included in the group of ununited fractures.

The one feature common to the other cases is a low calcium and phosphorus product. The figures given here are not, strictly speaking, the absolute product of the calcium and phosphorus ion; since, in addition to calcium and phosphorus as ions, some exists in the blood as the triple calcium phosphate, less as the double salt, and least as the monovalent

salt. The product, however, taken as the product of the calcium and phosphorus, each in milligrams per one hundred cc. serum, would seem sufficiently accurate for clinical purposes. The eight patients in whom there was a deficiency in either element were placed on a diet, and the blood picture followed weekly. Only the findings at the time of non-union and after healing have taken place are given in the tables. Those patients presenting a low phosphorus were placed on a high protein diet with liver, three ounces, three times a week; buttermilk, five hundred cc.; calcium carbonate, three grams; cod-liver oil one teaspoonful; raw fruit or vegetables (oranges, slaw, etc.) daily. This dietary was suggested by Dr. E. V. McCollum. It contains the necessary food accessory substances, in addition to a sufficiency of the inorganic bone forming elements. In those patients presenting a low calcium, the cod-liver oil was withheld from the diet until callus formation was evident. In one patient, D. L., (Case 1), the mercury quartz lamp was used in radiation, in place of cod-liver oil. The back and chest were exposed daily for fifteen-minute intervals. This is believed to be the first instance wherein the mercury vapor quartz lamp has been used as an adjunct in the therapy of non-union. In another patient yellow phosphorus, one one-hundredth grain twice daily, was given as a source of phosphorus. Phemister, already referred to, called attention to its value in the healing of fractures. Both of these patients, together with five others of the eight treated, have gone on to healing. One has concomitant osteomyelitis. In summary, seven patients have healed, one is still ununited.

From our observations in the healing of these fractures, it would appear that no healing takes place with a product less than thirty, little healing between thirty and thirty-five, active healing takes place between thirty-five and forty. These observations parallel those made by Howland and Kramer in the healing of rickets. In those cases presenting a low calcium, the product is, as a rule, not as low as in the low phosphorus cases.

The length of time necessary to increase the calcium and phosphorus in the serum was found to vary not only in different patients but also as regards the different elements. Little change in the blood serum could be noted until the patient had been three weeks on the diet. As a rule an even longer period was necessary before the product became normal.

As a control series to this, nine presumably normal patients with fractures were taken and the calcium and phosphorus content of the serum determined. These were followed from week to week, as regularly as possible, to determine the calcium and phosphorus picture as healing took place.

Included in this series were four patients under twenty and five over twenty. The series was, as nearly as possible, similar to the non-union group in so far as age was concerned. In the selection of these patients no special precaution was taken to choose those having a particular fracture, it being assumed that the same physiologic stimulus effect would be produced, regardless of the site of fracture. The group included seven fractures of the forearm, one fractured clavicle, and one fracture of the humerus. The first determinations were made as early as possible after fracture, usually on the same day.

Table 3 shows the calcium and phosphorus content in milligrams per hundred c.c. serum at time of fracture.

TABLE 3.

| | *Calcium* | *Phosphorus* | *Product* |
|---|---|---|---|
| E. D. | 9.7 | 4.0 | 37.6 |
| J. D. | 8.2 | 4.0 | 32.8 |
| F. P. | 10.9 | 4.1 | 44.6 |
| T. S. | 10.7 | 4.0 | 42.8 |
| M. B. | 10.2 | 3.8 | 38.7 |
| J. K. | 10. | 3.6 | 36.0 |
| W. B. | 10.4 | 3.5 | 36.4 |
| H. W. | 10.5 | 3.7 | 38.8 |
| M. G. | 10.4 | 3.4 | 35.3 |

In Table 4 are given the findings after healing has taken place.

TABLE 4.

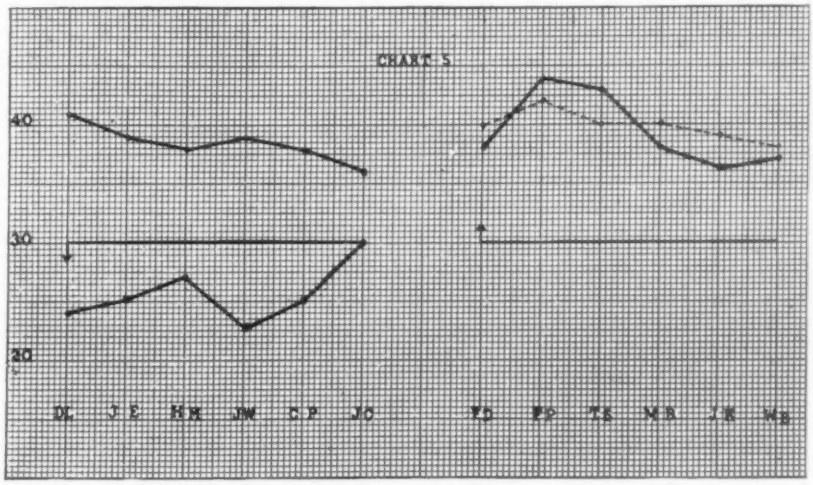
| | *Calcium* | *Phosphorus* | *Product* |
|---|---|---|---|
| E. D. | 10.0 | 4.0 | 40.0 |
| J. D. | 9.8 | 4.1 | 40.1 |
| F. P. | 10.6 | 4.1 | 43.4 |
| T. S. | 10.6 | 3.8 | 40.2 |
| M. B. | 10.0 | 4.0 | 40.0 |
| J. K. | 10.0 | 3.9 | 39.0 |
| W. B. | 10.5 | 3.6 | 37.8 |
| H. W. | 10.4 | 3.8 | 39.5 |
| M. G. | 10.3 | 4.0 | 41.2 |

The study shows the average phosphorus in these cases to be 3.7 milligrams; the average calcium to be 10.1; average product approximately thirty-seven. The study does not reveal any material increase in phosphorus or calcium during the process of healing.

One case proved of special interest, namely that of J. D., whose calcium, as seen from the table, was 8.2 at the time of fracture, and which

increased slightly each week, but remained continuously low. Delayed union was predicted in this instance, and on February eighteenth, four weeks after fracture, the roentgenogram showed no formation of callus, and there was false motion at the site of the fracture.

From the clinical study of these normal fractures there seems to be considerable evidence to show that when healing takes place, the product of the inorganic constituents of the blood, calcium and phosphorus, lies between thirty-five and forty. This would appear to be the minimum product for healing. This may be more readily appreciated if one compares the figures found in these patients with those of the non-union group shown in Chart 5.




Non-union Group Normal Group

Here are given the products found before and after healing in the six low phosphorus individuals of the non-union group as contrasted with the figures found before and after healing in six of the normal adult patients. It will be seen that in the presence of non-union of the low phosphorus type the product is below thirty, and that when healing occurs this figure is above thirty-five. In the normal adult with fractures the product in uneventful healing is thirty-five or above.

## SUMMARY OF CLINICAL STUDIES.

From these observations on the healing of ununited fractures, it has been demonstrated that in many cases, though not in all, there is as an

underlying basis, a constitutional disturbance, which is made manifest as a deficiency in the concentration of the inorganic bone-forming elements of the blood. This deficiency is shown either by a subnormal phosphorus or calcium, in most instances the former. Here a reduced product is the rule, though in those cases with a deficient calcium, the product does not reach as small a figure as does the product in those patients with a low phosphorus.

Clinically and chemically these patients may be classified into two groups: (1) those who clinically show no callus and who chemically show a low calcium; (2) those who show callus and in whom a low phosphorus is found. How accurate this classification may be, remains for further observations to determine.

In those patients with fractures which go on to normal healing, the condition is quite different. In these individuals the normal calcium and phosphorus concentration is found. Their optimum product for healing would appear to lie between thirty-five and forty; whereas in those patients with non-union a product of less than thirty was the rule.

It has been observed that no healing takes place with such a reduction in the product. Little healing takes place with a product between thirty and thirty-five; active healing takes place when the product is, as shown in normal fractures, between thirty-five and forty.

Patients with non-union, in whom there is a deficiency in one or the other of these elements will, when this deficiency is compensated by an adequate dietary, go on to normal healing. As a dietary, the one employed in these patients seems sufficient. Cod-liver oil should be employed in small doses and only after callus formation. In one instance the mercury quartz lamp was very effective in raising the product. More studies are necessary before the best method can be determined.

The deposition of calcium salts in the bony matrix probably depends upon some balance maintained between the blood and the bony matrix, perhaps through an intermediary, the osteoblast. If the blood contains an adequate concentration of these elements the cell can take them up and pass them on to the matrix; if, on the other hand, the blood is deficient in the elements, the process, is probably reversed.

## CONCLUSIONS.

1. In many cases of ununited fractures, there is as an underlying basis a constitutional disturbance responsible for the condition, demonstrable as a deficiency in the inorganic bone-forming elements of the blood.

2. This deficiency shows itself as either a low phosphorus or a low calcium, in most instances the former. In those patients presenting a low phosphorus there is usually an abundant callus, but no calcification; whereas those patients with low calcium usually show little or no callus.

3. No healing of the fracture takes place when the inorganic constituents, calcium and phosphorus, are so reduced that the product of these elements is less than thirty; little healing takes place between thirty and thirty-five; active healing results with a product between thirty-five and forty.

4. Patients with ununited fractures in whom there is a deficiency of one or the other of these elements will, when the deficiency is compensated, go on to healing.

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## DISCUSSION ON PAPER OF DR. PETERSEN.

Dr. Philip D. Wilson, Boston, Mass.: The lateness of the hour demands that I say nothing, but on the other hand I feel that the importance of this work of Dr. Petersen is too great to let it go by without comment.

Non-union in fractures has always been a mysterious thing. We always seek a mechanical explanation, either in the lack of proper apposition of the fragments or in the interposition of tissue between their ends. There are many cases, however, in which this explanation is not adequate. Non-union frequently occurs in cases treated by open reduction and in which complete approximation has been secured and complete fixation provided. What is the cause of these cases? Sometimes we find the patient has tabes, or syphilis without involvement of the central nervous system may be present, and yet even then we are not answering the question because we have no knowledge as to how these diseases act. Then there is also the factor of general health. It has always been recognized that non-union is common in a certain type of child, with pasty skin, pale color, and blue sclerae. Then again there are the cases of long standing pseudarthrosis in which various bone grafting operations have been performed without improvement. Here evidently a general rather than a local factor is at fault, and it seems to me that in Dr. Petersen's work we may have the explanation.

I do not think that Dr. Petersen means to suggest that the disturbed calcium phosphorus balance is the explanation of non-union in every case. I am sure he agrees that mechanical factors play a considerable part and that the chemical disturbance may follow rather than precede. It is difficult to say which is cause and which effect. Certainly from the standpoint of treatment it would be futile to introduce a bone graft

unless one had first restored the normal calcium phosphorus balance. The chemical changes are similar to those found in infantile rickets, and evidently there is an analogy between the two. We know that rickets may be prevented or cured by exposure to sunlight. May not the cause of the chemical changes reported by Dr. Petersen lie in the fact that most cases of ununited fracture have spent months in hospital confinement with a considerable part of the body enveloped in plaster? At any rate, we must make an effort to apply heliotherapy to these cases as a preventive measure, and in the future the open air ward may be as much of a necessity for the treatment of fractures as it is now in tuberculosis. Evidently further work remains to be done, but I believe Dr. Petersen has opened a door for us through which we may see a land of rich promise.

# THE BLOOD VISCOSITY IN TROPHIC DISTURBANCES OF CIRCULATION

## A PRELIMINARY REPORT

BY WALTER G. STERN, M.D., F.A.C.S., CLEVELAND, OHIO.

Under a large variety of names there exists a rather vague group of circulatory disturbances of as yet unknown origin which the writer has always felt were of usual orthopaedic interest. The chief symptoms are pain and disability in the extremities—principally in the feet and calves—together with coldness, numbness, cyanosis, loss of pulse, intermittent limping, appearance of painful papules and skin spots, ulcerations of the skin, and gangrene of varying degrees of severity.

The generic term "angiotrophoneurosis" has been universally applied to this entire group of symptom complexes. This term has been shortened by Dr. Willy Meyer to "trophoneurosis," but as this name could also be applied to non-vascular conditions, the term "angiotrophosis" seems more appropriate, should a shorter name seem desirable.

The symptoms in angiotrophosis may vary in severity from a mild burning pain or limping, as in erythromelalgia, to trench foot and symmetrical gangrene; and to these various and varying manifestations the names pulseless feet, *frost schwielen*, erythromelalgia, erythrodynia, intermittent claudication, thrombo-angiitis, endarteritis obliterans, trench foot, spontaneous gangrene, Buerger's disease, "Yiddisch" disease, Raynaud's disease, etc., have been applied.

It has always been the belief of the writer—based partly upon the common findings of a high blood viscosity and the presence of painful papules—that these various symptom-complexes are closely related to one another and that they differ fundamentally only in the severity of the toxic or harmful agency causing the disease and the susceptibility of the individual to the noxious forces at work. It is beyond the question of a doubt that the Polish and Gallician Jews and the Swedes in North America and the Japanese are more susceptible to this trouble; especially are they the victims of that type called Buerger's disease, thrombo-angiitis or spontaneous gangrene. The writer has seen many cases, some of them lasting for years, which presented, at various times, symptoms characteristic of more than one form of this affliction. A few examples might be cited.

M. P.; female; age 18; has from earliest childhood had cold, clammy, burning, and painful hands and feet. The symptoms were always worse in winter. There are and have been no heart, lung, or kidney lesions of any kind. The circulatory symptoms gradually grew worse each winter, and of late, crops of painful papules have appeared on the feet and there are also several larger, discolored, indurated, and painful patches of skin on the lower third of the legs. In the winter 1923–24, she adopted the prevailing mode of extremely light and scant clothing. In February, 1924, she noticed the papules and skin spots to be more extensive and painful than usual, the feet were constantly blue and swollen, and deeply ulcerated areas of skin appeared on and between several toes and over the heel cords. The fingers are also blue and cold. The pulse in both dorsalis pedis arteries is absent; Wassermann, spinal, blood, and urine chemistry are all negative. Metabolism low; blood viscosity, 6.0 Hess.

After one month's treatment which consisted of rest, electric light baths, sodium iodide intravenously, and Koga treatment with Refuss tube with 4000 to 5000 C. C. Ringer's solution daily, she showed a lowered viscosity, 5.0; her feet were warm, the pulses reappeared, the ulcerations were all healed, and the painful spots not in evidence. The toes are still cold, especially on a chilly day.

Mrs. S.; age 36; married; has several healthy children, presents exactly the same history, clinical picture, and clinical findings as the above M. P. There was, however, one larger indurated skin patch on the lower shin, which remained quite painful. This was excised and a large button-like mass of indurated fat removed. The laboratory report reads as follows:—"The skin shows no characteristic changes; the fibro-fatty tissue shows a number of small areas of haemorrhage with a small amount of granulation tissue, few wandering cells. The small arterioles show marked thickening of the intima with stenosis of the lumen; there are a few medium-sized veins. Final (laboratory) diagnosis: Endarteritis."

A. L.; male; age 32; has always had "chilblains," and on this account did not see active duty at the front in France. Two years ago he "froze" his feet while automobiling in Ohio, but this experience did not cause him any immediate disability. Last winter, he noticed several crops of painful spots over the skin of both feet and ankles. He experienced considerable discomfort but was able to carry on. This winter (1923–24) the pain has become excessive and a spot of gangrene has appeared on his great toe. He is an excessive smoker. Physical examination negative except for the condition of the feet as before noted; blood and urine chemistry negative. Blood viscosity 6.2; arterial sympathectomy did not improve condition. Excision of a piece of vein in calf of leg does not show any pathologic changes.

Since the writer's previous communication before this society, at least three operations have been offered for the alleviation of the symptoms of this condition, but have failed of universal recognition and have been discredited.

The operation for the reversal of the circulation has been advised by Wieting and ligation of the femoral vein by Lilienthal, but neither procedure has commended itself to the profession and both have been abandoned.

Another operative cure has been offered by René Leriche of Lyons, France, who, in many brilliant articles, has advanced the operation of arterial sympathectomy as a cure for this and kindred conditions. Leriche contends that the arteriole spasm is due to irritative vasoconstrictor impulses travelling down the sympathetic nerves and that these sympathetic nerves reach the terminal arterioles only or mainly in the adventitious coat of the arteries and not via the nerve trunks, as held by many anatomists; and so if one stripped the artery of its outer coat the circulation would thereby be increased and the relief of symptoms would follow. Leriche measures his improvement by an instrument known as the "Oscillometer of Pachon," made by Boulitte of Paris.

The writer has had two cases of traumatic angiotrophosis, where after rather light crushing wounds of the foot (no bones fractured in either case) the injured member became painful, cold, cyanotic, and swollen. The pulse of the dorsalis pedis was missing in one case and very small in the other. An intense osteoporosis developed and the patients were absolutely unable to bear any weight upon the foot. The feet were extremely cold at all times and had to be protected with woolens and sheepskin in winter. In both cases, one a young man of twenty-four, the other a married woman of thirty eight, an arterial sympathectomy gave prompt relief from all the symptoms, the feet became warm and painless, and the increased use was soon followed by a gradual return of the lime salts to the bones.

The studies of Buerger of New York on the end results in the veins and arteries in one type of case, first designated by him as thrombo-angiitis obliterans, to which he has added a description of migrating phletitis—have become a classic. Buerger's beautiful descriptions and illustrations of thrombosed and canalized veins and arteries will always remain a masterpiece; but his statement, (Circulatory Affections of the Extremities, page 308) "when the patient comes to the physician for observation, the larger arteries and often the larger veins are completely obliterated," is a doctrine of pessimism and despair to which the writer cannot subscribe. Buerger in his tremendous experience has only a few—a very few—cases which do not ultimately come to gangrene and amputation, while in his limited experience,—although he has seen many cases of limited gangrene or trophic ulceration,—the writer has seen very few come to amputation, and in at least two cases, where the veins were excised, the finding of the most exquisite and classical pictures of thrombo-angiitis according to Buerger was not even accompanied or followed by gangrene, or even by unusually severe circulatory symptoms. In fact, M. P., age 42, a champion long distance swimmer, has made a complete recovery since the time a few of his veins were excised for diagnostic purposes, and pronounced by Buerger,

to whom the specimens were sent, some eight years ago, to be typical of thrombo-angiitis. True, the man's whole mode of life had to be changed, and he was compelled to give up swimming, smoking, excesses of all kinds, undue exertion in walking and exercising, and always to protect his extremities from cold.

During the war, the occurrence of "Trench Foot," clinically indistinguishable from thrombo-angiitis with or without gangrene, necessitated close study. The English and French observers attempted to explain it on the grounds of infection, but never convincingly. Sweet, Norris, and Wilmer, of Philadelphia, on the basis of clinical study alone, offered the theory that trench foot was merely the reaction of individuals suffering from angiotrophosis (unrecognized by the military medical authorities and therefore allowed to serve in the trenches) to the continued inaction, cold, and dampness of the trench service, plus also compression from tight shoes and puttees. They showed that the blood pressure of the leg was higher than that of the arm in all cases measured. The cases of the trench foot from our own forces which the writer saw after their return in the spring of 1918, reminded him strongly of his own cases of angiotrophosis from civil life.

The most recent observation, and one which promises thorough confirmation, is that of a Japanese physiologist, Mayesima, that the majority of these cases show a permanently high blood viscosity. The corollary of Koga, of Kyoto, follows that the subcutaneous injection of large amounts of fluid could reduce this increased viscosity, allay the symptoms, and check the spread of existing or threatened gangrene.

McArthur, of Chicago, modified Koga's treatment by giving large quantities of fluid (4000 to 6000 C. C. of Ringer's solution) directly into the duodenum by means of a Refuss duodenal tube. In our own work, we have followed McArthur, and where the Koga treatment is mentioned, the Koga-McArthur procedure is meant. Willy Meyer, of New York, also praises Koga's discovery highly and it is due to both him and to McArthur that the Koga treatment has been recognized in America.

Soon after Koga's publication in the Zeitschrift f. Chir., Vol. 121, the writer endeavored to determine blood viscosity, not only in outspoken cases of gangrene or threatened gangrene, but in all types of angiotrophosis, mild or severe. The simple viscosimeter of Hess was procured in 1917 and has been used since then to the exclusion of all other instruments. All viscosities mentioned in this paper (as in the publications of Koga and others) are based on the Hess instrument at room temperature. (In our steam-

heated apartments, offices, hotels, and hospitals in this country, the room temperature does not vary enough to make it worth while computing the actual readings of this instrument and reducing them to a theoretical mean temperature basis, although the instrument is provided with a thermometer and tables for this purpose.) The Hess viscosimeter may not be an instrument of fine precision for the determination of absolute viscosities, but for the basis of comparison its accuracy is sufficient. Its calibration is such that the readings of one instrument can be compared with that of another.

The principal of the apparatus is that it sucks both water and blood into thin, calibrated capillary tubes at the same moment,—therefore under the same barometric pressure and the same temperature—with the same force, and the difference in the distance the two fluids travel up these capillary tubes is the measure of their relative viscosities.

Viscosity can be defined as the resistance of a fluid to the relative motion of its parts, or the resistance to a change of form under stress; viscosity can also be defined as "fluid friction." As measured by the Hess instrument it possibly depends somewhat upon the solid contents of the blood as well as the thickness of the blood serum, as in two cases of pernicious anemia, as well as one case of severe secondary anemia, the blood viscosity was very low (below 3.5), but was soon raised in one case after blood transfusion. It was very low, 3.2 and 2.9 in two cases of hemophilia with quite normal blood counts. In two cases of polycythemia the viscosity was very high (5.8 and 6.4). The high viscosities found in true cases of angiotrophosis were in every case combined with quite normal blood counts and blood chemistry.

Outside of the above six observations, a constant inquiry with over 450 observations into blood viscosities in health and in various pathologic conditions, especially the circulatory disturbances of the extremities, revealed practically normal viscosities in the various groups of diseases, except the circulatory disturbances already spoken of as angiotrophosis. Not that isolated cases of non-vascular disturbances did not now and then register a high viscosity and that cases of undoubted angiotrophosis were not found with normal readings, but deviations from the above rule were few and not constant. As far as could be determined, the only group with a persistently high blood viscosity is, as before mentioned, the angiotrophosis group, 85%. (No undoubted case of Raynaud's disease was observed, and all data on this form of gangrene are lacking). Chilblains (pernio) did not show a viscosity above the normal limits. A few cases of claw foot (Jones' foot) showed enough circulatory disturbance of the limbs to lead us to take

blood viscosities. Of four cases examined, two had viscosities above the normal (5.2 and 5.6). The other two were normal. In this connection, it might be noted that Mills in his paper on the topic of Claw Foot (Amer. Jour. of Bone and Joint Surgery, Jan. 1924) rejects Volkmann's ischaemia as a cause for this condition, but in a personal communication says "Claw foot is usually ill nourished—it seems to me quite feasible that a gradual ischaemia from endarteritis might be one of the factors by causing weakness and degeneration of the intrinsic muscles." The writer has also in mind several similar cases seen many years ago where the circulatory disturbances produced as much discomfort as did the hollow foot and the hammer toes.

It was shown by Koga that hypodermoclysis will lower the blood viscosity at once, and by McArthur that the duodenal exhibition of Ringer's solution will produce the same effect. Our own observations are in accordance with the above, but on account of the enormous difficulty of handling and controlling this type of patient, we were unable to determine how long the lowered viscosity persisted after stopping the intake of the excess of fluids. The longest period we found was four weeks. Several writers have also claimed that the intravenous exhibition of sodium iodide will cause a considerable reduction in the blood viscosity.

It is of interest to note the findings in the matter of the blood viscosity in cases of more or less severe disturbances of circulation of known causes.

| *Condition* | *Gangrene* | *Viscosity* | *Blood Count* |
|---|---|---|---|
| Traumatic | No | Normal | Normal |
| Traumatic | Yes | Normal | Leucocytosis |
| Varicose Ulcers | No | Normal | Normal |
| Varicose Veins | No | Normal | Normal |
| Syphilitic Ulcers | No | Normal | Normal |
| Perforating Ulcer | No | Normal | Normal |
| Diabetic Gangrene | Yes | Normal | Normal |
| Cervical Ribs | No | Normal | Normal |
| Cervical Ribs | Yes (one case) | Normal | Leucocytosis, Anaemia |
| Arterio Sclerosis | No | Normal | Normal |
| Arterio Sclerosis | Yes (one case) | Normal | Normal |
| Carbon Monoxide Poison | Yes | Normal | Leucocytosis, Low Reds |
| Senile Gangrene | Yes | Normal | Normal |
| Phlebitis | No | Normal | Leucocytosis |
| Embolism | Yes | Normal | Normal |
| Chemical Gangrene | Yes | Normal | Leucocytosis |
| Spina Bifida | Yes | Normal | |
| Foerster Operation | No, Ulcers | Normal | |

SUMMARY

Angiotrophosis, which includes the so-called Buerger's disease or thrombo-angiitis obliterans, is the only disease with a normal red blood count in which a high viscosity is *not* an unusual exception. In this disease 85% of all cases investigated had blood viscosities of 4.8 or over.

This finding, the presence of painful papules, the clinical pictures of trench foot (see Sweet, Norris, and Wilmer, Jour. A. M. A., Vol. 70, No. 7) and the clinical course of many cases confirms the writer in his opinion that this entire group of conditions is more or less related and is usually amenable to treatment, a view which offers a much more favorable prognosis than that given by Buerger.

In the immediate case the treatment should consist of rest in bed, bland diet, heat in the form of continuous electric light baths to the extremities, the ingestion of from 4000 to 6000 C. C. of Ringer's solution by means of the duodenal tube, and sodium iodide intravenously. After the acute symptoms have subsided the treatment should consist in an entire change in the habits of the individual in order to diminish the functional demands upon the local circulation, and the avoidance of all forms of toxic absorption from whatever source, the circulation exercises devised by Buerger, and at the same time the ingestion of large quantities of water to keep down the blood viscosity. The body must at all times be protected from being chilled or compressed, not an easy matter in these days of light clothing, openwork shoes and stockings, and tight, narrow shoes.

# THE CAUSE AND TREATMENT OF CERTAIN TYPES OF LOW BACK PAIN AND SCIATICA

BY GEORGE I. BAUMAN, M. D., CLEVELAND, OHIO.

That there should be a great diversity of opinion as to the cause of such a common ailment as backache, or sciatica, and such a varied assortment of treatment suggested for its cure, is very good evidence that the correct explanation of the condition and, in consequence, the correct treatment, has not been found.

It is not the purpose of this presentation to list and discuss all of the causes of pain in the back or leg, but rather to consider in some detail one or two very common types of this disability. Absorption from some focus of infection is specifically excluded from this discussion. This is a very common cause of low backache and leg pains, and the possibility of trouble from this source should be excluded first of all in every case.

It should be understood that in recent or mild cases operation is not advised, and in almost every case reasonable conservative measures have been, and should be, tried before the patient is subjected to operation.

In the class of cases under discussion, there is more or less constant pain in the lower back, with (usually) pain referred to the lower abdominal, hip, or leg regions. The only complaint may be of the referred pain. This is mostly of sudden onset and traumatic origin, although in some the onset is insidious, in which case some of the various congenital anomalies (especially sacralization of the fifth lumbar vertebra) are to be considered.

Believing that the etiology of many of these cases was to be found in some lesion of the nerve trunks, and that this lesion was most likely in the lumbar or lumbo-sacral region, a careful study of the anatomy of the lumbar and lumbo-sacral plexus, especially regarding relations to certain parts of the lumbar vertebrae, has been made. In this investigation, a great deal of help was obtained by the study of stereophotos of a dissection of this region, made by the Department of Anatomy of W. R. U. Medical School. In this dissection, (Reference 1, Fig. 1,) one will notice that many of the nerve trunks come in intimate contact with certain transverse processes. This observation is not original, of course; it may be found in books on anatomy, and the close relationship has been found many times in operations upon these transverse processes. It is further suggested by the

report, about six years ago, of the removal of the fifth transverse process without nerve injury; it was the first time this had been accomplished (and reported). The relationship is sufficiently close to require extreme caution in doing the operation of transversectomy. If such caution is used, however, nerve injury is entirely unnecessary, as I have demonstrated in a number of such operations. If we admit then, that this relationship is so extremely close, it seems just to conclude that any lesion of a transverse process is likely to be followed by some lesion of the nerve trunk in contact with it. There has been some discussion as to just what this lesion could be.

In a series of about thirty-five operative cases, a tuberculosis of the transverse process was encountered in one case, and in no other case was there any evidence of disease which could account for the pain. From this fact, and from the fact that many other cases which were not operated upon showed roentgenograms negative to any disease, it seems safe to conclude that disease in any form affecting any part of the lumbo-sacral or sacro-iliac region is a very rare cause of pain in the class of cases under discussion. Excluding, then, the element of disease as a cause in at least a very large number of the cases, let us consider the etiologic factor from the mechanical standpoint; that is, from the standpoint of pressure.

Many of the cases are of sudden onset, and occur mostly in men doing hard labor. A heavy lift or strain with a sudden feeling as of something giving way, or snapping in the lower back, followed by sharp pain and decided weakness, is a common history. Frequently, the first pain is confined to the lower back and may ease up quickly, so that the man is able to return to work the same day. It may be one, two, or three days before the pain comes on in the leg and becomes so severe as to make physical work impossible. The fact that the man works a day or so after his injury, and then lays off, immediately places him under suspicion as a malingerer. This history is so common, however, that in justice to the patient some other explanation must be offered.

I am certain that the pain is due to pressure upon the lumbo-sacral nerve trunks, and hope to prove this in the following discussion, but one can only theorize as to the cause of delay in many cases. It is just as difficult to explain the long delay in the appearance of symptoms in the case of cervical ribs, and when a satisfactory explanation of this phenomenon is found, it will apply, I think, just as satisfactorily to these similar cases. The similarity between cases of sacralization of the fifth transverse process and cases of cervical rib has been spoken of by others, but there are two points of dissimilarity which might be noted. It seems to be taken for

granted that the pain in the arm is due to pressure upon the cervical nerve cords, and that the removal of the rib will relieve the pain, whereas it seems to be necessary to prove that the pain in the leg is due to pressure upon the lumbo-sacral nerve cords, and that it will be relieved by removal of the offending transverse process. The second point of dissimilarity is the great frequency of the lumbar spine cases and the great infrequency of the cervical rib cases.

Studying a skeleton in which there is an unilateral enlargement and sacralization of the fifth transverse process, one will note that there is a distinct bulge forward of this process as compared with the opposite normal process. This could very readily produce pressure upon the nerve cord passing over it. This was beautifully illustrated in one operation. In removing the deepest anterior part of a sacralized process there were distinct muscle twitchings indicating the close proximity of a nerve cord (this has been observed several times), and as the last of the process was withdrawn, the nerve cord seemed to follow it up across the wound until it occupied a position about one inch nearer the surface than it could have occupied before. This nerve cord must have been stretched tightly across the process and pressed upon by the process. The sciatic pain was relieved in this as in almost every one of the operated cases.

The following observation, which has been made in many cases, is offered as further proof that the referred pain is due to pressure. The highest point of tenderness over one of the transverse processes is found (usually over the fifth), and very firm pressure is applied with the thumb at this point. The patient frequently says that this increases the pain down the leg, and this increase in pain may last for several hours after the examination. This short period of increased pain may be followed by a longer, also temporary, period of relief of pain. The latter observation has also been made by others, and used as a basis of treatment. Pressure upon a nerve trunk is a rather old and, I believe, a discountenanced method of treating various other forms of neuritis or neuralgia. I have had no experience with this kind of therapy in the class of cases under discussion. It would seem logical to suppose that the temporary increase of pain in the leg following such a test was due to some alteration in the relationship between the transverse process and the nerve cord, and that this change increased the pressure upon the nerve cord.

Another cause of pressure I believe to be due to rotation of the lumbar spine. The occurrence of rotation together with lateral curvature is frequently observed by the surgeon and roentgenologist, and brings up the old discussion as to cause and effect. In at least some of these cases the

rotation in the lower lumbar region seems to be toward the side of pain; I would suggest, therefore, the explanation of the referred pain as due to the advanced position of one of the transverse processes. This rotation, then, occurred at the time of the accident; is the cause of the pain, and can be removed in some cases by a manipulation of the spine with or without an anesthetic. It is probable that most of the cases relieved by this method are cases of rotation or twist.

The process itself is not always responsible for the pressure. A study of skeletons exhibiting a sacralized or unusually large fifth transverse process shows in many an abnormal foramen of exit for the nerve trunk. As this may be quite small, the possibility of pressure at this point is suggested. After removing the fifth in one patient, a tight thread of fibrous tissue was found spanning the nerve. In another, a small nest of bony tissue was removed from one of the nerve trunks. In every case after removing the suspected process the nerve trunks should be palpated as far as possible to be sure they are free from pressure. This is not at all difficult after the process is out of the way.

The reasons given are sufficient, I believe, to substantiate the theory of pressure of a transverse process upon a lumbo-sacral nerve cord as the cause of pain in the back or leg in the class of cases under discussion. For these cases the name lumbo-sacral neuritis is suggested. This term covers the more common sciatica due to some lesion of the fifth as well as the less common, but equally interesting, neuritis, due to a lesion of one of the other lumbar transverse processes.

The third is frequently elongated, especially in women, and is therefore easily injured. A knowledge of this has cleared up several hitherto obscure cases of complaint of pain in the lower abdomen, groin, or hip region.

To make a correct diagnosis, one must keep in mind the location of the transverse process and the distribution of the branches of the lumbo-sacral nerves. After an accurate history is obtained, it is usually possible to go directly to the highest point of tenderness in the lumbar region, and this highest point will usually be the point of maximum tenderness. This point should be marked, and the whole back searched for other points of tenderness, little attention being paid to the lower points as these are usually referred. If the patient can be confused on the location of the points of tenderness, one should be suspicious of a functional neurosis. Deep pressure is often necessary to elicit the pain, but equally deep pressure should be applied to the corresponding point on the opposite side for comparison.

If one is suspicious of the third, the trouble will usually be found near the tip and this may be four inches from the mid line. The end of the third transverse process may frequently be palpated, especially in thin women. The location of the fifth is found by following back the crest of the ilium to the line of the spinous processes. In the angle thus formed, one produces very firm and deep pressure with the thumb.

Limitation of motion and muscle spasm are usually found in these cases, but they are so variable that no great reliance may be placed upon them in making a diagnosis. In those cases having neuritis in the leg there is usually increase in pain on straight-leg raising, and frequently the patient complains of pain in a certain spot in the lumbar region. I believe this is due simply to stretching the sciatic or lumbo-sacral nerves, and has little value in diagnosing the exact location of the trouble.

Many interesting things have been encountered in the study of this subject. One patient was brought in by his physician to see about amputating the leg. He had had a periarterial sympathectomy on the advice of an orthopaedic surgeon. He had as clear-cut a case of neuritis as one could possibly wish. There was marked tenderness over the fifth transverse process and increase in pain in the leg on pressure at this point. Several hitherto obscure cases in children of slight paralysis, paresis, hypoplasia, or other developmental defects in the leg, have been explained, or at least made more interesting, by the finding of congenital anomalies in the lumbar spine.

It goes without saying that many of the cases had received various diagnoses, especially lumbo-sacral or sacro-iliac disease or strain, and had been treated in various ways without benefit.

In a previous article,[1] I reported nineteen operative cases. In estimating the value of the operation, one case of tuberculosis should be eliminated. Of the rest, as far as can be determined, fourteen are cured, three improved, and one unimproved. With more experience and with better judgment in selecting cases for operation, and selecting the proper process to remove, I believe the percentage of cures may be further increased. A considerable number of more recent operations could now be reported but the results have been similar to, or better than, those reported in the previous paper, and the added experience has not altered my opinion as to the cause of the trouble.

In all of this work care has been used to avoid any other treatment to which any benefit obtained might be attributed.

SUMMARY

I.—Many cases of pain in the lower back or leg or both, are due to some lesion of one of the lumbar transverse processes.

II.—This lesion consists in pressure upon a nerve cord and results in a condition which should be termed lumbo-sacral neuritis.

III.—The condition may be readily diagnosed, chiefly by the study of definite points of tenderness over certain transverse processes.

IV.—The trouble may be relieved by removing the appropriate process.

REFERENCE

1. The Relation of Lesions of the Transverse Processes to Pain in the Back and Legs, by George I. Bauman. Journal of Bone & Joint Surgery, Vol. XXI, No. 3.

# AN ADDUCTION SHOE-WEDGE.*

BY JOHN JOSEPH NUTT, M.D., NEW YORK, N. Y.

Mechanical derangement of the foot such as is designated by weak feet, flat feet, pronated feet, etc., is accompanied by three deformities: a slight equinus at the tibio-tarsal joint; an eversion at the sub-astragaloid, and an abduction at the medio-tarsal joint. When no pathologic changes have taken place other than atrophy of the overstretched muscles, especially of the anterior and posterior tibials, and elongation of the ligaments on the inner side of the foot, proper treatment is plainly indicated: reduction of deformities and restoration of normal functions.

In our armamentarium we have a large supply of apparatus for accomplishing these ends, but it is difficult to change the position of a moving part, retain it there, and yet allow the normal range of motion.

Preventing deformity with restriction of motion must increase weakness, and on the other hand, if motion is allowed, deformity must remain. Therefore, each case demands an analysis as to whether the predominant

FIG. 1

Wedge extends supporting surface of sole backwards and inwards after anterior inner corner of heel is raised.

*Read by Title at the Meeting of the American Orthopedic Association, May, 1924.

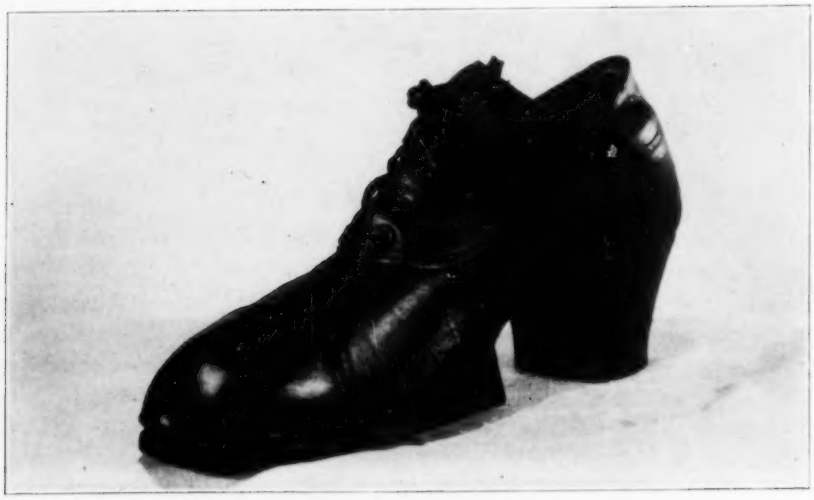

FIG. 2

Upright posterior edge of wedge extends downwards and inwards, not straight downwards.

FIG. 3

Rear view of adducting wedge. On a small heel, its wedge extends further backwards.

condition is one of deformity or of weakness, and treatment must be planned to accord.

The wedging of shoes, both heels and soles, is of common practice, but wedging in the fashion to be described is, I believe, original. As two years' trial has convinced me of its superiority over other methods, I wish to offer it for your consideration.

The shortening of the gastrocnemius must be overcome by a traction shoe or by tendon lengthening; the eversion by wedging the heel into inversion, and the abduction by a wedge under the first metatarsal.

The heel wedge does not extend all along the inner side of the heel, but is placed at the front only. It tilts the os calcis upward and backward as well as outwards.

The metatarsal wedge reaches from the supporting surface to the part of the sole under the first metatarsal. It flares inward, and materially helps to prevent eversion, but does not invert the foot.

These wedges are not to be used with dorsal flexion limited to 90° or more, nor with a non-flexible shank shoe, nor without instructions and training in normal walking.

I have found them of great value in correcting deformities, relieving strain, and in function-training.

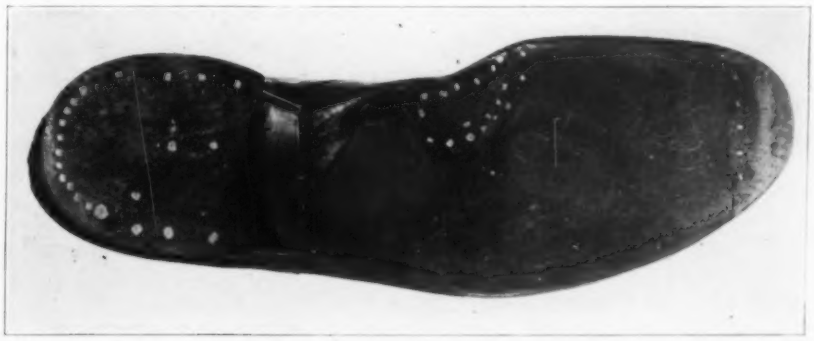

FIG. 4

Shank made flexible by removing steel and slashing.

# DISPLACEMENT OF THE INTERNAL SEMILUNAR CARTILAGE IN A BOY OF FOUR YEARS

BY FREDERICK CHRISTOPHER, M. D., F.A.C.S.

*Junior Surgeon, Evanston Hospital, Evanston, Ill.; Assistant Surgeon, St. Luke's Hospital, Chicago, Ill.; Assistant in Surgery, University of Illinois Medical School.*

The semilunar cartilages of the knee-joint are recognizable in the embryo at the beginning of the fourth month.[1] At birth they are flat, but definite, structures and they undergo considerable increase in size in the second year with the onset of walking. These cartilages are subject to traumatic displacements, most usually between the ages of twenty and fifty. The internal meniscus is far more commonly injured than the external, in the ratio of 9 to 1.[2] The cause in the case of the internal meniscus is a sudden strain on the internal lateral ligament of the knee, with the foot abducted. The cardinal symptom, sudden inability to extend the joint, is absent in about 30 per cent. of the cases.[2]

The youth of the patient whose case is reported below is thought to be of sufficient interest to warrant recording. Elmslie[3] says the accident "may occur at all ages, though it is rare before adolescence." Bradford and Lovett[4] say that it "rarely occurs in children." Out of 2000 *operated* cases the youngest was thirteen years.[2] Porter has never seen a case as young as the present one.[5]

Johnson[6] says he has never seen a case of what appeared to be a fracture or dislocation of a semilunar cartilage which recovered permanently as the result of conservative treatment. Jones and Lovett[2] say "so large a proportion of cases make a good recovery under mechanical treatment that we should discourage operation when a patient is seen at once with a first displacement, nor should one urge operation where a recurrent trouble is painless and is not followed by effusion into the joint." Graham[7] advises a bandage, instead of a cast, in the non-operative treatment. Love[8] studied the prognosis after removal of semilunar cartilage in a series of fifty cases. He concluded that it was good in 70 per cent. of the cases, fair in 22 per cent., and poor in 8 per cent.

This patient, J. B., 4½ years of age, marched in a children's parade on July 4, 1924, after which he complained of pain in his right leg, but which was not of such severity as to prevent his walking home, some six blocks. Immediately after his return home at about 5 P. M., the patient lay on a couch and pulled or drew up his right leg, and his nurse noticed that he was unable to extend it. The leg remained in acute flexion all night and the patient woke several times saying his leg hurt him.

At 3 P. M. on the 5th the parents took the child to their pediatrist, who did not make a diagnosis, but observing the tension of the hamstring tendons and the inability of the patient to extend the leg, referred him to the writer.

The child was carried into the office, holding the right leg up in flexion at about a right angle. There was no pain, but efforts to extend the leg actively or passively occasioned not only severe pain but encountered a definite resistance. There was a tender point over the internal aspect of the knee-joint.

A diagnosis of displacement of the internal semilunar cartilage was made. Efforts to reduce the dislocation were made by acutely flexing the leg on the thigh and rotating the leg as much as possible while in this flexed position. These manoeuvers seemed to be fruitless, when the child's leg suddenly extended to full extension and he stood up without pain and walked.

In order to permit the healing of the torn attachments of the meniscus, the leg was immobilized in a light plaster cast extending from the ankle to just below the groin for nineteen days, during which time the patient was allowed to walk freely. The cast was then removed and an elastic stocking, reaching four inches above and below the knee, was applied. The inner side of the heel of both shoes was elevated three-sixteenths of an inch. The motion in the joint was free and painless and the child walked easily. There has been no recurrence to date (August 25, 1924).

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## RECENT CONTRIBUTIONS TO THE SUBJECT OF HELIOTHERAPY.

At its Annual Meeting, held in Baltimore in May of this year, the American Orthopedic Association had the privilege of listening to a communication from Dr. Rollier of Leysin on the subject of heliotherapy.

The position which Dr. Rollier holds in the medical world is unique. An early exponent of heliotherapy, he has developed a clinic of unusual proportions, and so situated topographically that there are brought to the patient the ideal conditions of altitude and the proper quality of sunlight and air, and under these conditions the varied clinic affords opportunity for observation and for study of results.

With these facilities Dr. Rollier has much to give to the medical world out of his experience. Unfortunately, the paper of Dr. Rollier, with its many illustrations, is too long to publish in this Journal, but the editor is acknowledging its value and regrets that only an abstract will appear in these pages. Much information of value in reference to the early history of this method of treatment is given in the first part of the paper, and later the methods of its application and the results are described in detail.

The Association also had the opportunity of hearing a paper on the same subject by Dr. Lo Grasso of Perrysburg, New York.

Too few of the medical profession are familiar with the excellent institution of which Dr. Lo Grasso is in charge and of the efficient work accomplished in it, in spite of the lack of altitude and mountain air. It is to be regretted that this paper cannot appear for the same reason, and an abstract is given below.

It is hoped that the authors will publish these papers in full, and the Journal will be pleased to give to its readers the reference to such publication.

Short abstracts of the two papers follow:

Dr. Rollier, in his paper on "Helio-Alpine Treatment of Joint Tuberculosis," spoke as follows:

The manifestations of external tuberculosis, no matter where they may be located, are no more than local symptoms of a general infection. In the rational treatment of surgical tuberculosis reliance should be placed chiefly on the therapeutic resources of nature. Heliotherapy is the ideal method and may be practised wherever the sun shines, in the plains, by the sea, and in the mountains. But it is in the high altitudes

that the most favorable conditions are obtainable. The rarefied air increases the rate and depth of respiration and leads to an increased oxygenation of the blood. The solar radiations lose less of their energy.

The resistance of an individual is proportional to the degree of his pigmentation. With Dr. Rosselet we attribute to it a transforming function analogous to that which Dreyer attributes to certain fluorescent substances which can transform short into long wave lengths, the latter more penetrating. The sun-bath increases the flow of blood to the muscles. Its action is shown in a quickening of the appetite, the increase in the number of blood cells, and nutrition and tissue exchange becomes more active.

It is certain that the sun acts through the whole spectrum and not by virtue of one group of rays. The experiments of Weisner have proved that the infra red rays have bactericidal power and exercise a direct influence on deep seated foci. Bloch tells us that the rays at the red end of the spectrum exercise a vaso-dilator action which favors the influx of phagocytes. Recent experiments lead us to conclude that the blood upon which sunlight plays becomes a receptacle for radiant energy. This is transported to all parts of the organism, hastening the intercellular processes of oxidation and reduction.

The sun's rays exert also a local effect, rapidly diminishing pain, and in rebellious sores heliotherapy destroys the infective germs. In Pott's disease we may observe a progressive sclerosis of the extensive vertebral lesions and with it the disappearance of cold abscesses or the firm calcification of their residue.

The prognosis in cases with secondary infection is much less favorable. Our cases of surgical tuberculosis never die of tuberculosis but of cardiac weakness or amyloid degeneration following secondary infection.

The method of carrying out heliotherapy is to expose the feet and legs first. Procedure is made by short intervals of a few minutes each separated by intervals in the shade. The head is covered by a white linen hat and the eyes by smoked glasses. In some cases a cloth is placed over the heart. The patient's pulse temperature and contingent reactions are watched and at the least sign of intolerance the periods of insolation are shortened. When fully pigmented, three to four hours a day in the winter and two to three in the summer are a normal amount of dosage.

In order to arrest tuberculosis in childhood the first heliotherapeutic preventorium was founded in Cergnat in 1910. Children from schools are sent here and given heliotherapy. School is combined with this. It is hoped that these preventoria in the mountains will become annexes to the schools in the towns.

Dr. Lo Grasso, in his paper on "Heliotherapy in the Treatment of Bone and Joint Tuberculosis," laid stress upon the following points:

Rollier first pointed out that in bone and joint tuberculosis we are dealing not with a localized disease but with a constitutional one with localized manifestations. Patients with bone or joint lesions are put to rest and kept there not only until all signs of activity have disappeared, but with few exceptions until all sinuses and ulcers have healed and abscesses have become absorbed or calcified.

In my opinion motion within the limit of pain is not harmful but beneficial, preventing ankylosis and atrophy of the part. Casts defeat the purpose of heliotherapy by excluding light from a large portion of the body and producing atrophy of the muscles. Before sun cure is begun it is best that the patient should be gradually accustomed to

out-of-door life. During summer no irradiation is applied during the middle of the day, as insolation at this period is depressing. Exposure is gradually increased five minutes to each part till one hour's exposure three times per day is reached. During insolation sinuses and ulcers are covered by a wire screen. On days when sun cure is not feasible an air bath is given.

The results with artificial light are decidedly inferior, first because no artificial light in common use resembles sunlight in intensity and spectral distribution, and secondly because artificial light is usually given in ill-ventilated rooms. Experimental treatment with a new lamp devised by Dr. Brian O'Brien at Perrysburg has shown that a smooth tanning of the skin is obtained apparently in every way like that of the sun. The patient is warmed by the light so that it may be given in open air.

In the course of the sun cure the skin becomes pigmented. Cutaneous eruptions disappear, muscles become firm, there is a rapid alleviation of pain, temperature drops to normal, and weight and strength are rapidly acquired. Abscesses often increase in size during the first two or three months, and during this time they are repeatedly aspirated if they threaten voluntary opening. If their contents are too thick a small incision through healthy tissue is indicated. The effect of the sun upon bone tissue is to increase repair with intense recalcification.

In Pott's disease a hard pillow is placed under the kyphes. When turned on the abdomen a triangular pillow is placed under the chest. In high dorsal and cervical cases traction is resorted to. In hip disease, traction on an inclined plane is used; at the knee, traction and if necessary a pillow under the head of the tibia to prevent subluxation. In all lesions, except tuberculosis of the spine, as soon as pain and muscle spasm have disappeared, motion within the limits of pain is encouraged and is increased until as much as possible of full function is obtained.

Up to January 1, 1924, there have been discharged 252 cases of bone and joint tuberculosis and 23 cases of osteomyelitis. Fifty-four per cent. were apparently recovered, 26 per cent. arrested, 10 per cent. improved, 6 per cent. unimproved, and 3 per cent. died. None were discharged as cured until they had been up for six months without return of symptoms. Seventy-six per cent. of all joint cases were discharged with partial or full motion. Nineteen per cent. of adults and 16 per cent. of children had diagnosable pulmonary lesions. The average duration of illness before admission was two and one-half years.

# CLINICAL CONFERENCE, HOSPITAL FOR THE RUPTURED AND CRIPPLED, NEW YORK, MARCH, 1924.

THE PRESIDENT, DR. KRIDA, IN THE CHAIR.

DR. R. WHITMAN—Fusion Operation for Spondylitis Deformans.

The patient, a man 23 years of age with advanced spondylitis deformans, was sent by a former patient with the aim of preventing the deformity from which he suffered.

Since the age of twenty years the patient has had periodical yearly attacks of acute rheumatism. For about five years he had noted an increasing stiffness of the spine and posterior curvature. For two years he had suffered much from sleeplessness because of pain in the back and chest.

The patient was in good condition. There was no joint involvement. He presented a moderate fixed posterior curvature of the spine with the characteristic anatomic changes and symptoms of spondylitis deformans not involving the upper cervical joints. He was placed on a convex frame on February 19, 1924. This relieved the pain and lessened the deformity. Spinal fusion from the sixth cervical to the tenth dorsal inclusive was performed on March 10th. On March 17th, he was again placed on the frame in order to still further reduce the deformity during the process of repair.

In this case the prognosis was especially good because the disease had not extended to other joints, and it would appear that the fusion operation should check the progress of deformity and thereby modify the effects of the disease.

Dr. S. KLEINBERG—Costo-Transversectomy for Vertebral Disease with Paralysis.

This case is presented because of the difficulty in making an accurate pre-operative diagnosis and the indications for costo-transversectomy.

Mrs. L. W., 33 years old, admitted to hospital February 2, 1924. She was well until four months ago, when she awakened one morning with pain in her back. The backache persisted, and one month later she felt weakness of her lower limbs. On admission she presented an angular deformity of the spine at the level of the tenth dorsal vertebra. She was unable to walk or stand. In bed she was able to move her legs. The knee jerks were exaggerated. Roentgenograms showed destructive disease of the tenth dorsal vertebra and an abscess shadow about the ninth, tenth and eleventh dorsal vertebrae. There was no lesion in any other part of her body. Diagnosis of Pott's disease was made. Two weeks later there suddenly appeared complete paralysis of motion and sensation below the umbilicus, incontinence of urine and feces, and marked hyperesthesia above the umbilicus. The knee jerks were exaggerated and pressure sores appeared over the sacrum, buttocks, and lower limbs. There were no Bence-Jones bodies.

It was decided that the paralysis was the result of pressure of an abscess on the spinal cord and a costo-transversectomy was performed. The body of the diseased vertebra was reached easily and the vertebra was found to be bare of any ligamentous coverings. About a teaspoonful of yellow granular fluid which looked like tuberculous pus was removed. No abscess cavity was found.

Scrapings from the region of the vertebrae were examined microscopically and showed a very cellular and vascular spindle cell sarcoma. Since the operation roentgenograms have been made of the entire skeleton. An ophthalmoscopic and gynecologic examination was then made. No evidence of sarcoma in any other part of her body.

This is a case of primary sarcoma of the spine. The patient is now being treated by Dr. William B. Coley with injections of his mixed toxines.

DR. A. KRIDA—Bunnell Transplant for Severed Flexor Tendons of Finger.

Dr. Krida presented a young man of 21, upon whom he had operated in July, 1923. Eight weeks previously the patient had cut the tendons of the middle finger while cutting bread. The tendons were sutured by a practitioner in Dartmouth, N. H. There was apparently some infection, as the wound took about five weeks to heal.

Examination showed that there was an oblique scar across the palmar aspect of the middle phalanx. There was no sign of activity in the flexor profundus digitorum. There was some activity of the flexor sublimis. The nutrition of the finger and the passive mobility of the joints was very good.

At operation it was seen that the flexor profundus tendon distal to its emergence from beneath the sublimis was represented by a very ragged thin fibrous cord which was intimately adherent to the underlying bone.

Operation consisted of a typical Bunnell transplant, the graft being obtained from the dorsum of the foot, a section of the extensor communis of the fourth toe being used. Both finger tendons were sectioned practically at the level of the metacarpo-phalangeal joint and both were united to the graft. The graft was anchored rather strongly opposite the joints with silk sutures.

On July 30th, it was noted that there was strong voluntary motion in the proximal joint but very little in the distal joint.

In December, 1923, the range of motion in the proximal joint was complete, and in the distal joint it was forty-five degrees. The transplanted tendon was apparently slightly raised from the underlying bone, but not to a degree sufficient to make it necessary to wear a ring. The patient states that the finger is perfectly efficient for all purposes for which he desires to use it, including playing the piano.

Examination March 27, 1924: no change from December examination.

DR. B. MOFFAT—Fractures with Dislocation of Astragalus.

The first case presented by Dr. Moffat was that of an adult male, aged 56, admitted May 28, 1923, to the orthopaedic service, Spring Lake Hospital, with the complaint of pain and disability of the right foot. History states that he was caught in a cave-in while digging in a sandpit.

Examination: Right foot is very edematous. There is much ecchymosis present. Foot hangs in position of marked plantar flexion and eversion. On the dorsum anterior to the internal malleolus there is an irregular mass palpable. The soft parts covering this mass are under great tension, and are apparently about to break down. Roentgenogram shows fracture of the external malleolus and luxation of all the astragaloid joints, the mass palpable on the inner side of the foot being the head, neck, and part of the body of the astragalus.

Operation: Under general anesthesia the foot was forcibly inverted in extreme plantar flexion, displaced backward, and put up in plaster within a right angle. Subsequent roentgenograms show anatomic restoration. Patient discharged November

20th. Foot is in good position and there is only slight limitation in the extremes of motion of the foot.

Case 2, age 30, was admitted to the orthopaedic service of the Spring Lake Hospital, January 14, 1924. History states that he slipped off the platform of moving train, his right foot striking the ground.

Examination: Foot is very edematous. There is much ecchymosis; marked eversion and dorsiflexion. The shaft of the tibia is palpable at the inner side of the sole of the foot.

Operation, January 15. Under general anesthesia on the fluoroscopic table, examination showed fracture of the fibula four inches above the external malleolus, rupture of the tibio-fibular synarthrosis, avulsion of the internal malleolus which is carried outward to the foot, luxation of the shaft of the tibia into the sole on the inner side, rotation of the astragalus in its long axis inward on the tarsus. The foot was first markedly everted to engage the sub-astragaloid joints, then inverted, plantar flexed, and adducted. The foot was put up in plaster at right angles in marked adduction and inversion. Roentgenogram shows anatomical restoration of the foot. Patient discharged April 26th. Bimalleolar diameter is increased. There is moderate inversion. Motion is limited only in the extremes. Weight bearing is painless.

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## CLINICAL CONFERENCE, HOSPITAL FOR THE RUPTURED AND CRIPPLED, NEW YORK, APRIL, 1924.

THE PRESIDENT, DR. KRIDA, IN THE CHAIR.

DR. R. WHITMAN—Bifurcation Operation, 2 Cases.

Dr. R. Whitman presented two patients on whom he had performed the Lorenz bifurcation operation. This operation, which was devised for irreducible congenital dislocation at the hip, ununited fracture of the neck of the femur, and similar conditions, had in his opinion a far more limited range than was claimed for it by Lorenz. It was essentially an oblique division of the shaft of the femur at a point opposite the acetabulum. The pointed extremity of the shaft was then thrust inward in abduction so that it might rest securely beneath the acetabular projection and thus assure a firm support in locomotion.

The first patient, a young man, had been injured in a railroad accident. The left limb had been amputated below the knee and the right hip dislocated. Attempts to reduce this several weeks after the injury had been unavailing and had resulted in paralysis. He was admitted to the hospital about one year later with the limb in the characteristic attitude of dorsal dislocation, the foot in equinus, and with only a trace of muscular power below the knee. An attempt to reduce the dislocation was contraindicated by an apparent fracture of the acetabulum and by the paralysis. The operation had been performed four weeks ago and the limb fixed in extension and about 20 degrees of

abduction, the equinus having been corrected by tenotomy. Already there was an appreciable return of muscular power as far as it might be observed in the toes.

Dr. Whitman presented a young man whom he had shown at a previous meeting. The case was one of spondylitis deformans of about five years duration, with increasing deformity and pain and sleeplessness. He had been placed on a convex frame to reduce the deformity and the entire dorsal region had then been fused, the aim being to relieve pressure on the vertebral bodies and to prevent the increase of the posterior curvature. The operation had been performed seven weeks before and the fixation was now stable. He has had no pain for several weeks and is now walking about wearing a plaster jacket to hold the spine in moderate lordosis and thus to relieve the strain on the dorsal region. This is to be replaced later by a stiffened canvas corset.

The second patient had been presented to the Society at a previous meeting to illustrate extreme deformity. About three years before, the spine had been injured, followed by paraplegia, contraction, and the usual bed sores.

The patient had been carried into the hospital and the subsequent corrective procedures for spastic paraplegia, including biceps transplantation, had been complicated by imperfect bladder control. The most important deformity had been a dislocation of the right hip, whether traumatic as stated by the patient, or secondary to the contraction, was not apparent. In this case the attempt to replace the dislocation was contraindicated and the bifurcation operation had been performed four weeks before. The patient had since regained voluntary control of the movements of the foot, and as a result of this and other operative procedures his more evident deformities had been corrected and his general condition had greatly improved.

Dr. P. W. Roberts—Chronic Arthritis of Knee: Operation, Diagnosis?

The patient, a woman of 34, had symptoms of pain, swelling, and disability in the left knee which had existed for eight years. Conservative treatment, such as immobilization in plaster, wet dressings, etc., gave no relief. The doctor in attendance during this period reported that repeated roentgenograms failed to show any bone lesion. This physician also reported that six years ago the right kidney was removed for a tuberculous lesion. Exploration of the joint was advised and it was found at operation that the synovial membrane was very much thickened and pathologic throughout. This was excised, and with it two masses of granular material resembling boiled cornmeal, one of which occupied a cavity in the head of the tibia. The wounds healed by first intention, and increased function was the immediate result. A guinea pig test of the material removed from the joint did not show tuberculosis. The Wassermann was negative.

Case was reported for discussion as to diagnosis.

Dr. S. Kleinberg—Specimen of Sarcoma of Spine.

The specimen was removed from the patient presented by Dr. Kleinberg at the last Clinical Conference. It included the vertebrae from the sixth dorsal to the second lumbar and a large tumor which grew from the tenth dorsal vertebra. The tumor completely destroyed the body of the tenth dorsal vertebra and partially destroyed that of the eleventh dorsal. The tumor extended to the left of the spine for several inches, but the bulk of the growth was to the right of the vertebrae. In the fresh state the tumor was about five inches in the vertical diameter, four inches in the transverse, and seven inches in the antero-posterior diameter. It was a solid, very vascular growth, free macroscopically from bone. It encroached on the mediastinum and was in contact with both lungs and the right leaf of the diaphragm. There were several small tumor masses on the

mesial surface of the middle and lower lobes of the right lung and on the superior surface of the adjacent portion of the diaphragm. These masses represent direct extensions of the primary growth and are not metastases. On the left side of the spine there was an abscess which extended to the lung, but was walled off from the lung parenchyma.

Posteriorly the tumor invaded and partially destroyed the posterior arches of the tenth and eleventh dorsal vertebrae and was adherent to the outer layer of the dura. When the tumor was separated from the dura, the dural sac was found to be intact.

The growth pressed upon but had not invaded the cord. For a distance of about an inch at the level of the disease the cord was flattened and reduced in size. The nerve roots were flattened and atrophied. Above and below this the cord was enlarged and there were numerous distended tortuous vessels on its posterior surface. Anteriorly also the cord was free. The conclusion from these findings is that the paralysis the patient suffered from was due to pressure upon and not the disease of the cord.

DR. I. ZADEK—Fracture of Internal Epicondyle of Humerus with Displacement into Joint.

Dr. Zadek presented the case of H. R., 18 years of age. Yesterday (November 15, 1922) patient was playing football and was running with the ball under his right arm, when he fell and injured the left elbow. Patient does not know the exact position the left elbow was in. The injury was soon followed by swelling and disability. Patient was admitted to the hospital where roentgenograms were taken.

Physical Examination. Patient in bed. The left elbow had had a soft bandage applied. This was removed. The elbow was swollen, particularly on the medial aspect. There was local tenderness most marked about an inch and a half above the articular border of the internal condyle of the humerus. There was likewise swelling and local tenderness at the articulation between the ulna, i.e., the sigmoid fossa, and the internal condyle of the humerus. The elbow was held at about 120 degrees and all movements were restricted and painful. The roentgenogram showed that a piece of bone the size of a large bean had apparently been broken off from the posterior aspect of the lower end of the humerus and an inch and a half above the articular border of the internal condyle and was now firmly wedged in the sigmoid notch.

Operation, November 21, 1923. Removal of bone fragment from the left elbow. An oblique incision three inches long was made extending from just behind the medial epicondyle across the front of the elbow joint. The ulnar nerve was exposed just behind the medial condyle, and by careful dissection the elbow joint was opened. A piece of bone the size of a grape was found firmly wedged in the sigmoid fossa of the ulna, between this and the internal condyle of the humerus. This bone was firmly adherent to the internal lateral ligament of the elbow joint which was still attached to the ulna. With some difficulty this fragment of bone was grasped with forceps and excised. Due to the complete tearing of the medial portion of the capsule, there was a play in the elbow joint in full extension of at least 15 degrees,—that is, from the normal carrying angle to a cubitus valgus. The capsule was sutured in place with plain catgut and all of the structures closed with plain catgut. There was the usual amount of discoloration and hemorrhage and a fair amount of oozing from the tissues. There were muscle fibers still attached to the bone fragment outside the capsule which ran down across the elbow. Plaster cast was applied, extending from the wrist to the axilla, with the elbow in full extension and fully supinated, and so applied as to relieve the strain on the internal part of the capsule.

December 10, 1922. Plaster removed. Wound healed completely. Contour of the elbow is normal. Patient is to gradually increase movement in the left elbow but not to put any unusual strain on it and is to strap plaster cast, which was bivalved, back on the arm when he retires. April 30, 1924. Patient now has almost complete flexion, lacking about 5 degrees, and lacks about the same amount of complete extension. Rotation is free. Condition is painless.

DR. E. VANDERWERKER—Slipping Patella, 2 Cases.

The two cases of slipping patella presented by Dr. VanDerwerker showed results following operation after ten months in the first case, and seven months in the second.

P. M., age 6, came in because of discomfort about the right knee and because she tired so easily. There was a history of congenital club foot on the same extremity, which had been treated in the clinic when she was a baby. The duration of the knee condition, as far as the mother knew, was about six months.

Examination showed there was still some remaining varus of the right foot. The right patella slipped over the outer condyle with the least flexion of the leg. This was not accompanied by any discomfort. The outer condyle seemed to be lower than the inner. Patellar ligament lax. At the operation a curved incision was made at the inner side of the right patella. The lateral ligaments or capsule of the patella exposed. It was found that the outer ligament was tense, and tended to draw the patella outward, while the inner ligament was relaxed and flabby. A vertical section about one inch wide was removed from the inner lateral ligament and the cut edges sutured with chromic. The outer half of the patellar ligament was split and removed from its insertion in the tibial tubercle, drawn underneath the inner half and implanted in the bone over the insertion of the gracilis, and also a chisel was inserted under the external condyle about three-fourths of an inch from its articulating surface and the edge split up without any bone peg insertion. The outer capsule, which was split, was not drawn together, but a bit of fascia pulled over it. Skin sutured with silk. Old club foot was stretched and plaster applied from the toes to the groin. The results have been very satisfactory in this case. There has been no recurrence of the dislocation of the patella. With extreme flexion of the knee, the patella remains in its groove and the outer condyle seems to be an effective barrier at the present time.

J. S., age 14½, had trouble with the left knee for two years following a fall in which her left leg flexed and the weight of the body fell on it. Occasionally left knee "snapped" and patient was unable to straighten her knee without some pain. No typical history of locking.

Examination showed left patella freely movable, particularly to the outer side of its groove. It rode over the crest of the external condyle with slight effort. She stated that the sensation she received when the patella snapped back into its groove was the same that she had experienced when she had the knee twisted and gave her the trouble for which she came to the hospital.

Operation: osteotomy of condyle and transplantation patellar tendon for slipping patella. Incision made along the outer border of left patella to tibial tubercle. The outer half of the patellar tendon was split vertically and removed from its insertion at the tubercle with a small bit of bone, passed underneath the inner half of the tendon, and implanted in the tibia. The small wedge of bone removed from where this tendon was implanted was inserted in a groove made with an osteotome through the outer

condyle, lifting the lobe of the condyle. Sutured with chromic. Subcutaneous catgut suture. Silk for the skin. Posterior splint applied.

This operation varied somewhat from the other case in that there was no reefing of the fascia at the inner side of the patella and the fact that the bit of bone was placed in the opening made with the osteotome in the outer condyle of the femora.

The result in this case has been very satisfactory. There was a little delay in complete recovery of function of the left knee and there was some persistent tenderness over the region of the transplanted bit of bone. Now patient has complete function at the left knee and no history of recurrence of slipping patella since operation.

DR. I. BALENSWEIG—Osteochondritis Dissecans of Knee.

Phemister states in a recent article that "The body comes from the lateral surface of the mesial condyle in the great majority of cases. The patella is occasionally the source, but bodies arising from the external condyle or from the tibia are extremely rare." The following case report concerns a loose body arising from the external femoral condyle.

Dr. Balensweig presented a case of a young male, age 20, clerk by occupation. Was first seen on February 5, 1924, complaining of pain and disability of the right knee; duration, three weeks. At that time, while playing basket ball, stopped suddenly, resulting in a rotation and flexion of the knee. He was unable to extend the knee and had to be assisted off the field. The affected joint then became swollen and stayed locked, making walking painful and difficult. Some three years ago, while sliding toward first base, the same joint was injured, staying swollen and painful for about one week, there, however, being no locking. Examination: patient walks with a right knee limp, with the joint slightly flexed and the foot in equinus. There is atrophy of the lower thigh on the medial aspect; some swelling of the knee, but no discoloration. A. G. E., 160 degrees; A. G. F., 140 degrees. The joint can be passively flexed to within normal limits, this being accompanied by an audible click and pain on the outer aspect. There is some swelling in the region of the external semilunar cartilage, tender to touch and the feeling of crepitation on palpation.

R.K.—35 cms.—35 31

L.K.—37 cms.—34 31

Diagnosis: Dislocation of the external semilunar cartilage of the right knee.

February 6, 1924. Radiographic examination both prior to and after oxygen injection. Antero-posterior view shows a widening of the interarticular space on the lateral aspect, with increase in density of this region. The lateral view reveals the presence of an oval shadow 1 cm. in its greatest diameter, situated on the posterior inferior aspect of the external condyle of the femur and separated slightly from it. There is a corresponding depression in the femoral condyle. Following oxygen injection the roentgenograms, although revealing nothing new, bring out the above more clearly.

February 11th. Operation. An S-shaped incision about six inches in length was made on the outer aspect of the knee, and the capsule incised over the mid portion of the semilunar cartilage. A good exposure was obtained by carrying the capsular incision up between the vastus lateralis and the quadriceps tendon. Inspection of the joint revealed no evidence of synovial thickening; the external cartilage was found to be very much thickened and slightly detached anteriorly. The cartilage was excised with but little difficulty. The knee joint was then acutely flexed, and disclosed a loose body in the posterior region of the joint and separated from the condyle by about one

sixteenth of an inch. A fringe of condylar cartilage overhung the loose body. This fringe was very thin and jagged. The loose body was found to extend across the entire width of the condyle and was attached by a fibrous pedicle to the medial aspect of the intercondylar notch. Removal was accomplished with a great deal of difficulty. Exploration revealed a depression about the same size as the removed portion but not quite the thickness of the latter. This cavity was lined with fibrous tissue and did not bleed. The joint was irrigated with saline and closed in layers. Dry dressing applied. No plaster was used. Recovery has been uneventful, and patient at the present time has regained complete range of motion of the affected joint, and suffers no discomfort.

DR. R. LEE—Fracture of Shaft of Femur: Ice Tong Traction.

Dr. Lee presented the following case: On February 9th, 1924, a plumber, age 47, while crossing the street, was struck by an automobile and was admitted to the hospital at 5 P.M. on the same day. Examination on admission revealed a comminuted fracture of the left femur, junction of middle and upper thirds, with three inches shortening of left lower extremity. Roentgenogram taken on admission showed a transverse fracture of the shaft of the femur with considerable over-riding of the fragments and a backward displacement of the lower fragment.

The thigh was suspended in a Thomas splint with adhesive traction, no attempt being made to overcome the displacement. Ten pounds traction were applied immediately and fifteen pounds added the following day. After three days it was noticed that the adhesive straps were slipping considerably and that there had been no perceptible change in the position of the fragments.

On the fourth day (February 14) the adhesive traction was removed and under ether anesthesia a pair of Pearson's ice tongs were applied to the lower end of the femur in the usual manner. Thirty pounds traction were applied, but roentgenograms taken at this time revealed an over correction of the deformity, and ten pounds were removed. There remained some anterior bowing of the femur which was satisfactorily corrected by means of wooden coaptation splints.

Roentgenograms taken at the end of two weeks showed good position of the fragments, and at the end of one month beginning callus formation. After six weeks (March 20th) the tongs were removed and a plaster spica including the foot was applied. Measurements taken at this time showed no shortening of the affected limb. There was a small draining sinus on the left side of the thigh as a result of the tongs, which necessitated the cutting of a window in the plaster for dressings.

The plaster was removed after one month (April 23rd), and roentgenograms taken then showed excellent position and firm callus. The skin wounds resulting from the tongs were entirely healed.

# CLINICAL CONFERENCE, HOSPITAL FOR THE RUPTURED AND CRIPPLED, NEW YORK, MAY, 1924.

THE PRESIDENT, DR. KRIDA, IN THE CHAIR.

DR. R. WHITMAN—Multiple Tendon Transplantations for Spastic Paraplegia.

Dr. Whitman said that he presented this case again to the Conference to demonstrate progress. It was one of advanced spastic paraplegia in a youth 19 years of age, and would illustrate the effect of multiple transplantation of muscles; the three hamstrings on each side having been transplanted to the patella. The contracted adductor tendons had been divided, together with the obturator nerve on both sides. It might be noted that tickling the soles of the feet no longer induced violent flexion at the knee and that the patient could now separate the thighs voluntarily to about two-thirds of the normal range.

This method, so distributing the power as to restore muscular balance, seemed to him more logical than the indirect method of operating either on sensory or motor nerves. In this case the mental improvement had been marked and was to be explained, he thought, by the relief from the strain of uncontrolled muscular activity.

DR. P. W. ROBERTS—Tuberculosis of Knee. Eight Operated Cases.

The operation consisted of resection of the synovial membrane and excision of the pathologic areas of the bone where these were small and circumscribed. Two recovered with practically normal motion; in four cases the joint was fused at a secondary operation; one, who had tuberculous lesions in the lungs and vertebrae, had an amputation as a life saving measure; one died of tubercular meningitis three months after operation.

From the experience gained in this series, the opinion is advanced that early exploration of tubercular joints is warranted both for the purpose of diagnosis and for the prevention of the extension of the pathologic process to the bones where the primary infection is located in the synovial membrane. If bone invasion has already occurred it is believed that fusion of the joint will shorten the period of disability.

DR. R. STEPHENS—Compound Fracture of Elbow—End Result.

Dr. Stephens presented the following case. R. B., 8 years of age. Admitted February 21, 1924. Eighteen hours before admission he fell forty feet down an air-shaft, landing in a pile of snow and striking on left elbow. Treatment before admission consisted of a simple dressing and a sling. Roentgenogram showed a severe comminuted fracture of the lower end of the humerus. Under an anesthetic the dressing was removed and the wound found to be just a small puncture over the tip of the elbow. This was painted with iodine and dry dressing applied. The elbow was markedly swollen and there was false point of motion and crepitus. It was very easy to get full motion at the joint but impossible to hold all the fragments in place. A sling was applied with a flannel bandage to hold the joint fully flexed. It was decided best to let the wound heal, get as much motion as possible, and later remove any bone that might be interfering with motion. Roentgenogram now showed that the position of the fragment had been changed, but was not satisfactory. Temperature rose to 102 degrees on the second and third days and then dropped, and inspection showed that the small wound was healed, the swelling subsided, and a few degrees of painless active motion present.

By the eighth day there was motion from full flexion down to 80 degrees. At the end of two weeks he was discharged from the hospital with motion from 45 degrees to 100 and normal pronation and supination. The internal condyle was very prominent and was freely movable. Physiotherapy was instituted three times a week for the next three weeks. A roentgenogram showed the callus forming, but the fragment, including the internal condyle, was still at right angles to its normal position and to the shaft of the humerus. This fragment finally projected through the skin. It was then decided best to remove this fragment at this time.

On March 29, 1924, with gas anesthesia, because of the presence of diacetic acid in the urine, the area of skin about the protruding bone was excised. The bone fragment was then easily removed and the ulnar nerve was seen to be lying in direct contact with it, and fortunately had never showed any signs of injury or irritation. With slight force, full motion could be obtained in the elbow. Up to this time it had been thought it would be necessary to do a still later operation to gain more function. The wound was closed and healed in a week. Since then he has had physiotherapy regularly three times a week and now has motion from practically full flexion to 175 degrees.

This case is presented as it has proven to me that it was distinctly best to avoid immobilization and to defer any radical operative procedure until we knew just how much function could be obtained and then how little we may have to do.

Dr. A. Krida—Fascioplastic Reconstruction of Anterior Crucial Ligament for Traumatic Genu Recurvatum.

Dr. Krida presented a case of a young man of twenty-one, who one month prior to operation had sustained a severe wrench of the left knee. He could walk only with the aid of a stick, and complained of pain and instability. There was considerable subluxation, a recurvatum of twenty degrees, considerable antero-posterior mobility, and moderately increased lateral mobility. Operation was done ten weeks ago, using the typical antero-medial muscle splitting incision. Both crucials were very thin and much relaxed. The anterior crucial was reconstructed by a combination of the Hey Groves and Alwyn Smith methods, a separate incision being made over the fascia lata. The patient has been walking for five weeks, and is now quite active. The stability is good, the recurvatum is cured, and he can flex to a right angle.

Dr. P. Colonna—Reconstruction Operation for Ununited Fracture of Neck of Femur.

Dr. Colonna presented a patient, age 47, who came to the hospital in April, 1923, on account of an injury received to the left hip by a fall from a wagon, sustained in January, 1923. This condition had been diagnosed by the family doctor as "laceration of the left hip" and patient was advised to remain in bed for a few weeks. When he presented himself at the hospital, examination showed fracture through the neck of the femur, and patient was admitted to the hospital, where a long plaster spica was applied with the limb in marked abduction and a slight inward rotation. Patient was under observation in the O. P. D. from April until October, and roentgenogram taken at that time showed only a very slight amount of callus at the point of fracture. In October, another long plaster spica was applied with the limb in marked abduction. Union at the point of fracture did not follow, and in April, 1924, patient was admitted to the hospital for reconstruction operation on the left hip.

Roentgenogram at that time showed shortening of 1½ inches on the left, with marked riding upward of the greater trochanter and almost complete absorption of the neck. The head of the bone was in the acetabular cavity, rotated slightly downward, and about normal in size.

On April 14, under gas ether anesthesia a fish hook incision was made, starting just behind the anterior superior spine, curving downward, then backward and upward. The line of demarcation between the insertion of the gluteus medius and the origin of the vastus lateralis was exposed; the greater trochanter chiselled off through the line of demarcation above mentioned. The loose head of the bone was removed from the acetabulum, the tendon of the ilio psoas divided, and by traction and marked abduction the newly formed neck was forced into the acetabular cavity. The trochanter major was attached to the shaft of the femur as low as possible, using kangaroo tendon for stay sutures. The wound was closed in layers, the skin with plain catgut, and a long body plaster spica applied extending from the axilla to the tips of the toes in about 35 degrees of abduction and with knee slightly flexed. Post operative course uneventful. A few days after operation a window was cut over the patella and patient was encouraged to move the patella. Three weeks after operation plaster was bivalved and active and passive movements given daily, after patient received baking and massage to anterior aspect of the thigh. Four weeks after operation plaster entirely removed and weight bearing begun with the aid of crutches. Five weeks after, patient was able to comfortably walk about the ward. Presented to conference six weeks after operation.

DR. M. GELLMAN—Case of Brodie's Abscess of Upper Part of Femur.

Dr. Gellman presented a case of a young man of twenty-seven who, during the past thirteen years, had complained periodically of pain and tenderness of right upper thigh. Thirteen years ago (1911), at age of 14, during the Fall, the patient was awakened one night with a pain, described as "gnawing or boring" in character, in the region of the right upper thigh. There was no history of preceding injury or local infection. The pain radiated down the thigh on the internal and external surfaces to the knee, but did not cause disability at the hip joint. The discomfort lasted one week, unaccompanied by either fever, chills, sweats, or a definite point of local tenderness. Then all symptoms disappeared, to return almost yearly each Fall, becoming more severe during the autumn of 1923. He had made visits to several clinics in the city, but not until prior to admission to this hospital was the true nature of his disease made evident, when a roentgenogram of the right thigh was taken, showing disease localized in the femur.

Examination in the O. P. D. on January 29, 1924, showed an uncomfortable, undernourished young man, walking carefully, shielding the right leg. Movements of the right hip were normal in all directions. There was marked tenderness on the internal and external aspect of the upper right thigh below the greater trochanter. Roentgenogram of this region demonstrated thickening of the periosteum and cortex about an irregular central area of bone destruction.

He was admitted and operated upon on January 31, 1924. Through an anterolateral incision, the upper right thigh was explored, dividing longitudinally the tensor vaginae femoris and vastus externus muscles, until the femur was reached. The thickened periosteum of the femur having been separated by an elevator, the bone was entered with a gouge. When the marrow cavity was reached, thick, yellow, creamy pus (culture: Staphylococcus aureus) began to escape. The bone abscess was thoroughly cleaned and troughed out and packed with Dakinized gauze.

The next day the packing was removed. The muscles, however, came together and obscured the cavity. Accordingly, a simple self-retaining retractor was devised and used, which aided materially the proper drainage, dakinization, and dressing of the wound. After several days' use, the retractor was discarded, as it had satisfactorily pushed aside the muscle tissue and allowed free access to the wound. Dakinization was continued for about three weeks, when suppuration lessened and healthy granulations were seen to invade the cavity.

The patient was seen in the O. P. D. for two weeks more and was finally discharged as cured around March 20, 1924, seven weeks following operation.

Roentgenograms were taken to show the final result.

PAUL COLONNA, *Secretary.*

# News Notes

The American Orthopedic Association has heard, with the deepest regret, of the death of one of its members, Dr. Robert E. Soule, of Newark, New Jersey. Dr. Soule died on May 1, 1924. He had been a member of the Orthopedic Association since 1910.

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On June 6, Prof. Maurice Denucé died in Bordeaux, France. Although he had been ailing for some time, his death was rather sudden.

Prof. Denucé was chief of both the Surgical and the Orthopaedic Services of the Hôpital des Enfants at Bordeaux, and Professor of Orthopaedic Surgery at the University of Bordeaux, and, apart from his great ability, he was a man of varied interests and possessed a delightful personality.

For many years he was one of the editors of the Revue d'orthopédie. At one time he gained much notoriety because it was he who amputated Sarah Bernhardt's leg.

While still a fairly young man, he wrote an extensive monograph on Spina Bifida in all its phases, a very remarkable piece of work, covering perhaps about a thousand pages.

Prof. Denucé will be remembered by orthopaedic surgeons chiefly because he devised a method of reduction by manipulation of congenital dislocation of the hip, with a very careful and thoroughly worked-out system of after-treatment. He succeeded in reducing great numbers of congenitally dislocated hips, and, moreover, in keeping the hips in and developing good function. His first list of cases comprised 725 hips, with just two final failures. Eleven of the 725 relapsed, but nine of these he was able to reduce at a second manipulation.

Aside from his medical interests, Prof. Denucé was extremely interested in all matters pertaining to music, and was head of the Conservatory of Music at Bordeaux.

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The Seattle Orthopaedic Society was organized last spring. The membership to this Society is open to men who are limiting themselves to the practice of orthopaedic surgery. The charter members are as follows: Dr. R. L. Jeffery, Dr. H. J. Wyckoff, Dr. J. C. Brugman, Dr. Minor C. Lile, Dr. Donald A. Murray and Dr. Roger Anderson. The following officers were elected: Dr. H. J. Wyckoff, president; Dr. R. L. Jeffery, vice-president; Dr. Roger Anderson, secretary-treasurer.

If orthopaedic men in other cities are contemplating a visit to Seattle, the Seattle Society would deem it a pleasure if they would notify them of their contemplated visit.

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Sol-e-Mar Hospital for Crippled Children, South Dartmouth, Massachusetts, had its formal opening Saturday, June 7, 1924. This Hospital is a new unit for crippled children, and aside from containing the usual hospital facilities will contain an Industrial and Educational Department. It is at present equipped with fifty beds, with possible

enlargement to 150 or 200. It is situated on a large farm, fronting on Buzzards Bay. The hospital is admirably situated and equipped to carry on extensive work in heliotherapy.

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We have received with much interest, from the Shropshire Orthopaedic Hospital, Oswestry, England, the first number of the Cripples' Journal, which introduces itself to its readers as follows:

"After some inevitable delay, the 'Cripples' Journal' makes its bow to the public. Its aim is to deal as comprehensively as possible with all subjects affecting orthopaedics. Our appeal is primarily therefore to all institutions, medical men, nursing staffs and helpers. For that reason it is hoped to make the pages of the Journal representative of every class of treatment in order that within the field of orthopaedic workers there may be some record of progress, not merely within the Shropshire area, but throughout all the areas and even beyond the seas. This journal is very properly issued with no intention of earning any profit beyond its upkeep and advancing the general cause of the cripple, both by the distribution of information and the raising of funds. It is burdened with no staff expenses beyond an honorarium to a secretary and the inevitable costs of printing and office expenses. The work is voluntary and it is well that it should remain so. Our appeal, therefore, is embarrassed by no personal considerations. It is directed toward the publication of articles by writers of established reputation upon subjects of vital interest to orthopaedic workers, toward the wider knowledge of current events here and abroad, toward the unity of all centres and workers, and thus to act as an expression of the progress of the work.

It is a natural question what part a journal like this can hope to take in the great campaign for the care and cure of the cripple. In a brief outline of the most prominent aims of propaganda the following are instances of the kind of publicity this Journal and all orthopaedic workers may unite in furthering:—

(*a*) To make the work and influence of orthopaedic hospitals and after-care centres more widely known and recognized among the general public.

(*b*) To provide an active agent for the financial maintenance of after-care centres and to advise and assist such centres in their publicity campaigns and appeals.

(*c*) To act as a general clearing house for all information of interest to orthopaedic workers here and abroad, and thus vitalize the sense of unity in a common cause. * * *

What is required most of all at this stage is a well-organized campaign against those dread diseases which rob childhood of its joy and bring manhood and womanhood to want and misery. These diseases are tuberculosis, osteomyelitis, rickets, and poliomyelitis. These are all preventable. Probably the first great cause of these diseases is industrialism and the inevitable herding of the majority of mankind in smoky towns. Secondly, as though the town dweller had not enough to put up with, the country sends to him impure milk charged with tubercle and every other germ that dirt can produce."

This first number of the Cripples' Journal also contains a foreword by Sir Robert Jones, in which he says, "The time has come, when, after years of pioneer work, the ground has been cleared and the foundations laid for a progressive and concerted movement, both medical and social, to solve the problem of deformity. * * * Beyond such schemes which mark the road of progress we must repeat until it becomes a commonplace that the *prevention* of deformity is our ultimate aim and destiny. Nor is it simply a splendid dream that the cripple will pass out of the text-books of medicine."

The Journal of Bone and Joint Surgery extends its best wishes to the Cripples' Journal.

The British Orthopaedic Association held a meeting at Bologna, Italy, on September 22 to 26, 1924. On September 22 and 23, a programme was arranged by Professor Putti at the Istituto Rizzoli. On the 24th a motor trip was arranged from Bologna to Cortina di Ampezzo (seven hours' journey), and on the 25th they visited the Codivilla Institute at Cortina. On the 26th the members of the Association went by motor to Bolzano in the Dolomites.

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The following notice has been received from the British Orthopædic Association concerning the Sir Robert Jones Medal and Association Prize:

The British Orthopædic Association offers a Prize of £50 and a Medal to be given by Sir Robert Jones for an Annual Competition amongst members of the Association of all grades for an Essay on a subject in orthopædic surgery.

The Essay is to be submitted typewritten, together with any illustrations and specimens, and forwarded to the Secretary on or before December 31st in each year. It must not bear the name of the writer, but should be identified by a motto and accompanied by a sealed envelope bearing the motto on the outside and containing the name and address of the writer inside. Only the envelope of the successful candidate will be opened. Unsuccessful Essays will be returned to the candidates on personal application.

The subject of the Essay for 1924 is: "The Diagnosis, Treatment, and End Results of Tuberculous Disease of the Hip Joint." Essays to be submitted by December 31st, 1924.

The subject of the Essay for 1925 is: "The Classification and Differential Diagnosis of the Different Forms of Arthritis." Essays to be submitted by December 31st, 1925.

R. C. Elmslie, *Hon. Secretary.*

# BOOK REVIEWS

1A, Portland Place, W. 1.

ARTIFICIAL LIMBS. APPLIANCES FOR THE DISABLED. Dr. Florent Martin. Geneva: International Labour Office. Studies and Reports. Series E (Disabled Men) No. 5. 1924.

All physicians who have had anything to do with amputation cases or the fitting of artificial limbs must realize the woful ignorance of the average limb maker and the need for dissemination of information as to the newer developments in prosthetic appliances. The medical journals do not furnish the proper vehicle for the interchange of ideas in regard to artificial limbs, but neither does any other publication at present.

The International Labour Office of the League of Nations at Geneva, acting upon the request of the Interallied Committee for the Care of Disabled Veterans, has undertaken to meet this need by the publication of a volume containing complete descriptions of all the different types of appliances used in the chief countries of the world. The task was entrusted to Dr. Florent Martin, Director of the Scientific and Technical Institute at Brussels, who acquired wide experience in limb fitting and its related problems during the war. The result reflects credit alike upon its author and upon the organization under whose auspices it was issued.

The volume contains about five hundred pages, divided equally between the upper and the lower limbs. There are about two hundred and fifty cuts, which are rather small and not as clear as might be desired. It is an exhaustive compendium of prosthetic appliances, by far the most complete which has ever been issued. It contains, in addition, chapters on the functional value of amputations at different levels and upon the care of the stump.

The book may be obtained in either English or French upon application to the International Labour Office at Geneva.

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AMPUTATIONS. Norman Thomas Kirk, M.D., F.A.C.S., Major, Medical Corps, U. S. Army. Published under the authority and with the approval of the Surgeon-General, U. S. Army. Copyright, *The Medical Interpreter*, 1924.

The literature on amputations and artificial limbs, almost nil before the World War, is gradually being enriched by the contributions of surgeons whose military duties provided special opportunities for the study of this subject. Although there have been many short articles in the American medical journals, practically all of the books have been by foreign authors. The present volume is the first attempt to present comprehensively the results of the experience of the Medical Corps of the U. S. Army in the care of our own cases. The volume is in monographic form and contains one hundred and ten pages, with about fifty large, clear cuts.

It covers not only the operative technique, but also the after-treatment and the fitting of the provisional and permanent appliances. The attempt is not made to go into

the subject of prosthesis in detail, but the author describes the standard models of artificial limbs supplied by the U. S. Army. Of special value are the descriptions of technique of amputation at different levels and of re-amputation and plastic closure in old stumps unsuitable for prosthesis. These procedures are the ones which were found to give the best results in actual practice, and they are quite different from the classic text-book operations, which proved unsatisfactory.

Major Kirk's reputation as a surgeon is well established, and his recommendations in this matter based, as they are, on a personal experience with seventeen hundred cases of amputation, deserve the careful study of all surgeons, and especially of those surgeons engaged in the industrial field.

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A Descriptive Atlas of Radiographs of the Bones and Joints. For students and practitioners. By A. P. Bertwistle M.B., Ch.B., Leeds, Resident Surgical Officer, General Infirmary at Leeds. New York: William Wood and Company, 1924.

The object of the Atlas is to provide students and practitioners with a handy book of reference for the interpretation of radiographs, thereby aiding in a more accurate diagnosis.

The author has incorporated several ingenious ideas in the Atlas. One which he names a silhouette radiograph combines the properties of a radiograph with those of a silhouette. The margins of the limbs are outlined on the negative, so as to give the impression of the contour of the soft parts as in a silhouette, which may sometimes be an advantage.

Another is that the normal plates throughout are shown on the left hand pages, while pathologic conditions appear on the right hand pages only.

There are six parts in the book. The first describes the silhouette process; then follow normal bones and epiphysis; fractures; diseases of bone; injuries and diseases of joints; a miscellaneous group of illustrations, which includes many congenital abnormalities. The paragraphs describing the radiograms are interesting and instructive.

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The Principles of Orthopedic Surgery for Nurses. James Warren Sever, M.D. New York. The Macmillan Company, 1924.

The Principles of Orthopedic Surgery for Nurses, by James Warren Sever, M.D., of Boston, published by the Macmillan Company, is the result of many lectures on orthopaedic surgery to nurses. The book contains about two hundred pages and takes up all the usual and some of the unusual conditions met in hospital orthopaedic service. It gives a good description of the conditions and the accepted forms of treatment. There is also a chapter on the various kinds of braces and splints used in orthopaedic practice.

The book will fill a much needed want and be a great help as a reference book to nurses and to those giving lectures on orthopaedic subjects to nurses.

The reviewer regrets that the writer should have been so dogmatic in his chapter on Painful and Irritable Backs, because not all orthopaedic surgeons could agree entirely with the opinions expressed.

INTERNATIONAL CLINICS. Vol. II. Thirty-fourth Series. Philadelphia: J. B. Lippincott Co., 1924.

The latest volume of this well-known series differs from many of its predecessors in that its contributors hail from widely separated cities and different clinics. The old policy of having each volume serve as the mouthpiece of a different medical centre has been changed. In variety of subject and amount and quality of material, it compares favorably with preceding volumes.

Of special interest to orthopaedic surgeons are the following articles: A Symposium on Physiotherapy, consisting of four articles; Poliomyelitis, by J. P. Crozer Griffith; Certain Affections of the Shoulder and Their Management, by Walter M. Brickner; A Clinical Lecture on Osteomyelitis, by Astley P. C. Ashhurst, and Metastasis, by O. H. Perry Pepper.

# Current Literature

## CONGENITAL ABNORMALITIES

CONGENITAL ELEVATION OF THE SCAPULA. Delchef. Revue d'orthopédie, November, 1923, page 623.

The normal limit of the superior border of the scapula is at the level of the first intercostal space, and the inferior angle reaches the eighth rib. Any elevation about these limits may be congenital or acquired. This paper deals only with the congenital form, often called Sprengel's deformity. Sprengel's description was published in 1891 (Revue d'orthopédie, 1891, page 476), but it was not the first work on the subject, papers having been written by Willett and Walsham in 1880 and Eulenberg in 1862. Rager (1901) claimed that the condition is not a true elevation, but rather an incomplete descent of the scapula. In 1922, Muller classified the different forms, according to cause: congenital scoliotic, paralytic, and due to torticollis.

The dimensions of the scapula are usually reduced, either in a symmetrical or asymmetrical manner. Rarely the bone maintains its normal size and shape. Its form usually seems to be a reversion to the embryonic shape. There is often a scaphoid or concave swing of the spinal border and a forward bend to the superior angle. In position, the bone is rotated outward so that the spinal border is no longer approximately parallel with the mid-spinal line, but makes a more or less wide angle with this line open above. There may be an elevation of 11 cm. A scoliosis of the cervical or upper dorsal spine sometimes accompanies the elevation. Other malformations which may accompany the condition are spina bifida (frequent), supernumerary or cuneiform vertebrae, ankylosis of two or three vertebrae, absence of first or first two ribs, cervical ribs. There is in about 10% of the cases a union of the scapula with a spinous process, usually the seventh cervical. The point of union, fibrous or bony, on the scapula is usually at the upper angle or upper end of the spinal border.

More or less atrophy of the neighboring muscles is usually present. The trapezius, subscapular, rhomboid, deltoid and pectoralis major are most often affected. The sterno-mastoid may be shortened, causing torticollis. Various other deformities have been noted in connection, notably, club feet, congenital dislocations, cleft palate, and facial asymmetry.

It is very rare that an infant is brought to the surgeon for this condition, because the deformity is seldom recognized in infancy. Patients sometimes do not come for treatment until ten to thirteen years of age. On first inspection the child may give the impression of a scoliosis, or torticollis, or cervical Pott's disease, but on close examination from behind the characteristic upward displacement and outward rotation of the scapula is noted. From the front, the superior-internal angle of the scapula is seen projecting above the clavicle, sometimes so prominent that it may look like an exostosis. The affected shoulder sets farther forward than the other shoulder, and the summit of the acromion may be as high as the level of the chin.

The elevated scapula is movable passively and actively in every direction except downward, unless there is union with the thorax. The movements of the arm in relation to the scapula are normal, but the movements in relation to the thorax are limited in proportion to the degree of fixation of the scapula. Abduction is particularly limited, and it is this symptom which usually brings the patient to the surgeon. The affected side is not as strong as the good side, and fatigues more easily, although the electrical reactions of the muscles are normal.

On the whole, the prognosis is not grave, but it must not be forgotten that there is a disturbance of equilibrium which has potentialities of other deformities, such as scoliosis and torticollis. In the few cases which have been under skilled observation over a period of years, no change for better or worse has been noticed.

Sprengel believed that the deformity came from a continued position of the arm behind the back. Paralysis has been said to be an etiologic factor. The author believes it is a developmental defect having its origin in the second embryonic month, when the scapula normally begins to descend from the cervical to the dorsal region. Considered thus, it is practically a malformation having to do entirely with the skeletal structure. It is noted that the closure of the vertebral clefs also occurs normally in the second month, and the coexistence of the spina bifida and other vertebral malformations is said to have some significance in support of the embryonic theory in regard to etiology of elevation of the scapula. This aspect of the subject is discussed in lengthy detail in the original paper.

Several methods of operation have been used to correct the deformity. Subcutaneous section of the rhomboid and trapezius followed by mobilization has been done by Eulenberg. Resection of the superior internal angle of the scapula has been done. Putti has fastened the scapula to the eighth rib by means of an artificial ligament with good result. The author has fastened it to the spinous process of the tenth dorsal and obtained good function. The muscle attachments on the internal border have been transplanted upward. A rational method devised by Ombredanne consists in fixing the upper edge to a rib after resection of the upper angle and pulling the scapula down, this fixation acting as a pivot on which the movements are made. The milder cases may yield to physiotherapy and braces.—*William Arthur Clark, M.D., Pasadena, Calif.*

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Non-reducible Congenital Dislocations and Their Treatment by Means of the "Forking of the Femoral End" Operation of Lorenz-v. Baeyer. Friedrich Loeffler. *Archiv f. Orthop. und Unfall-Chir.*, Vol. XXIII, 1. 1924, p. 38.

Adult patients with congenital dislocations, who suffer constant pain in the luxated hip joint, the lumbar and sacral regions of the spine, and radiating pain in the thighs, who are disabled in their walking to a great extent, and are afflicted with lordosis and adduction and flexion deformities of the thigh, should be submitted to corrective treatment. The bloodless operation is practically out of question; the open reduction is possible only in a very limited number of cases, and then the result is very doubtful while the procedure remains a very dangerous one. The Lorenz-v. Baeyer bifurcation operation is the only one which promises success in respect to increase of function, amelioration of pain, and improvement in appearance. Although it is only a palliative procedure, it is simple, without danger, and gives the best results in these obstinate defects. The author has performed twenty operations of this kind and has obtained

very satisfactory improvement in all the cases. The operation as outlined by Lorenz is as follows: Having previously determined the distance of the upper edge of the trochanter major from the acetabulum by means of a roentgenogram, the upper end of the femoral shaft is osteotomized obliquely. The osteotome is directed towards the acetabulum from the outside below to the inside above. The osteotomy should be complete. The lower end of the femur is turned inward by abduction of the leg, moved ventrally by slight hyperextension, and, by means of strong upward pressure, it is placed into the acetabular cavity. A plaster spica including the foot is applied, with the leg in 30–40 degrees of abduction and slight hyperextension. The plaster splint is kept on for twelve weeks. Eight days after the operation a roentgenogram is taken to learn whether the peripheral end is well in the acetabulum; if not, a correction is made in the abducted position. This procedure is applicable in other than congenital hip dislocations, such as pathological, traumatic and paralytic hip dislocations, pseudoarthrosis of the neck of femur, difficult cases of arthritis deformans, coxa valga luxans, etc.—*A. Gottlieb, M.D., Los Angeles, Calif.*

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THE RELATION OF PES VALGUS IN CHILDREN TO PES CALCANEUS IN THE NEWBORN. H. Trimmer. *Zeitschr f. orthop. Chir.* Vol. 45, 1924, p. 35.

Talipes calcaneus and talipes calcaneo-valgus have been recognized as such only if the deformities have been so markedly developed that the dorsum of the foot came to rest on the leg or very near it. The mild forms have been overlooked. To this oversight the author draws attention, and establishes the fact, on the basis of foot examinations of 80 newborn children (ages 1 day to 14 days), that about 10% of infants are afflicted with pes calcaneus or calcaneo-valgus. The latter diagnosis is made for any infant foot which can be dorsally flexed to a maximum, i.e., to the anterior surface of the leg, while plantarly it cannot be flexed at all or not beyond 40 degrees from the right angle. The normal limits in infants are: dorsal flexion, 50 degrees, and plantar flexion, 45 degrees. This congenital, although mild, talipes calcaneus and calcaneo-valgus develops in later life, when weight is borne, into pes valgus, which later in adolescence, changes into a pes plano-valgus, the typical flatfoot.—*A. Gottlieb, M.D., Los Angeles, Calif.*

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## OSTEOMYELITIS

OSTEOMYELITIS OF THE ILIUM IN CHILDREN. C. Bearse. *Boston Med. and Surg. Jour.*, May 22, 1924, p. 883.

Two cases of this condition are reported, with roentgenograms. Also there is a general summary of this condition. It is of rather infrequent occurrence. The etiology is the same as for osteomyelitis elsewhere. The pathology is somewhat different from that in the long bones, on account of the flat bones involved. Symptoms may be mild or severe, as in osteomyelitis elsewhere. Pain is located over the affected part. Roentgenograms show a punched out or vacuole appearance after the process has gone on long enough to cause destruction. Prognosis may be more grave on account of the proximity to the hip joint and the peritoneum. Complications are similar to osteomyelitis elsewhere. Treatment consists of early, liberal, surgical drainage and building up the general health to improve resistance.—*Fred G. Hodgson, M.D., Atlanta, Ga.*

OSTEOMYELITIS. U. Maes. *New Orleans Medical and Surgical Journal*, Feb., 1924, p. 365.

This is an excellent and concise statement of our present day ideas of acute hematogenous osteomyelitis.

The author urges early diagnosis as differentiated from acute articular rheumatism and acute infectious arthritis, and once the diagnosis is made, immediate operation before death of bone has taken place. He advises the use of Dakin Solution by Carrel's technique in sub-acute and chronic cases.—*Edward S. Hatch, M.D., New Orleans, La.*

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OSTEOMYELITIS OF THE ILIUM IN CHILDREN. G. Peeremans. *Archives Franco-Belges de Chir.*, Oct., 1923, p. 970.

At the Children's Hospital, Boston, in 548 cases of osteomyelitis the ilium was involved seven times. Four cases are reported in detail. The affection begins with pain in the hip, which becomes rapidly worse. The child is sick with high fever and leucocytosis, and signs of local inflammation appear. Movements of the hip are limited and painful, but if the examination is done very gently, considerable movement is possible in all directions, showing that the joint is clear. Exquisite tenderness and swelling appear over the involved area. The usual cause is the staphylococcus aureus. The roentgenogram is negative during the first week. The treatment consists of immediate and adequate drainage. Timid or so-called medical incisions may lead to extension of the local disease, metastatic abscesses elsewhere, or phlebitis.—*J. Albert Key, M.D., Baltimore.*

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## NEOPALSMS

REGENERATION OF BONE AFTER INTENSIVE RADIATION OF MALIGNANT DISEASE. C. C. Anderson. *British Journal of Radiology*, Feb., 1924, p. 37.

Anderson reports a small but instructive series of three cases, with roentgenographic findings corroborating the clinical observation.

The first patient was a man, 35 years old, with an osteosarcoma of the sternum, with enlarged bronchial glands. After surgical removal the treatment consisted of "an U. S. D. anteriorly (focal skin distance 60 cms.) and two applications posteriorly—each a full U. S. D.—employing the 10 x 15 applicator which has a F. S. D. of 30 cms." Six weeks later he was greatly improved locally when a metastasis was found in the left humerus. This resulted in a fracture before treatment began. This site received 3½ U. S. D. on successive days. Six weeks later the union was quite firm, although without a callus. Later the mediastinal condition led to a fatal result.

The second patient was a man of sixty, with a sarcoma of the region of the symphysis of the mandible. The treatment here consisted of the application of a full U.S.D. to the jaw and neck from either side, from an F.S.D. of 30 cms., and a further application to the mass in front. Two months later showed a marked improvement. The tumor still further diminished in size and increased in lime salts with subsequent treatments.

The third patient was a woman, 24 years old, with a diagnosis of round-cell sarcoma of the left ilium, which was enlarged to two or three times its normal size and presented to the X-ray two fractures, one just at the level of the acetabulum and one just behind the pubic symphysis. This case was given similar treatment to the others, and a

marked change for the better was observed in two months, with "no suggestions of a fracture, but the bone still presented a 'moth eaten' appearance."—*Charles A. Parker, M.D., Chicago, Ill.*

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PATHOLOGIC CARTILAGE GROWTHS. A. Policard and R. Leriche. *La Presse Medicale*, June 23, 1923, page 561.

There has been very little added to our knowledge of cartilage since the time of Virchow. With the idea of shedding some light on the numerous unsettled questions regarding the behavior of cartilage, the authors made a series of experiments and observations which form the basis of this paper.

As to the occurrence of cartilage in extraneous places, the theory of Virchow that it arises from embryonic inclusions of cartilaginous tissue must be dropped because experimental evidence fails to support it. There is no doubt that cartilage can appear where no such tissue was present. This is supported by many observations: for example, in a fracture of the ilium a mass of cartilage as large as a fist was found in the callus after nine days. Other instances are mentioned of the growth of cartilage after trauma in locations where it is not normally found.

Factors which influence the development of cartilage may be (1) mechanical, (2) serologic, or (3) character of the surrounding tissues. The mechanical factor is stressed by biologists, who hold that normally where there is a cleavage in the tissues and the opposing surfaces come together under pressure, a cartilaginous covering will develop. In rare cases cartilage has been observed in pseudarthoses, and Putti has found it in a knee a year after arthroplasty, it having developed from the fascia lata which had been transplanted. Under serologic factors the author goes into a theoretical discussion of "chondroid diasthesis" and of calcium and phosphorus equilibrium. As to environment it has been observed that connective tissue transplanted into a rabbit's ear changes into cartilage, but a piece of cartilage from the ear transplanted into the soft tissues always dies.

In new growths, such as chondroma and osteochondroma, the character of the tumor is somewhat dependent upon vascularization. If it has an abundant blood supply there is a tendency to form more bone, but if the supply is poor the tumor remains purely cartilaginous. It is the same phenomenon as obtains in physiologic development of bone from cartilage matrix, *i.e.*, the vessels must penetrate the cartilage before bone formation can take place. A complete absence of vessels, however, will result in necrosis of the part of the tumor thus cut off, and a liquefaction or cyst formation will result. Since the character of cartilage resists invasion of vessels it follows that most of these growths are prone to degenerate. As degeneration occurs, however, the way is opened up for vascularization, and a deposit of calcium salts fills up the spaces. It seems that the biologic laws which govern the physiologic state of cartilage also apply in a broad sense in the pathologic state.—*William Arthur Clark, M.D., Pasadena, Calif.*

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MULTIPLE SKELETAL METASTASES FROM CANCER OF THE BREAST. James E. Thompson and Violet H. Keiller. *Surg. Gyn. and Obstet.*, March, 1924, p. 367.

The very instructive case of multiple bone tumor, in which the diagnosis was not easy, is extremely well presented. The most interesting phase in this patient is the selectivity of the lesions.—*Edward S. Hatch, M.D., New Orleans, La.*

ABORESCENT LIPOMATA OF TENDON SHEATHS. J. Renfrew White. *Surg. Gyn. and Obstet.*, April, 1924, p. 489.

Two cases are reported in which the lipomata were formed in the tendon sheaths of the ankle. The first case soft, large, fluctuating swellings followed the course of the tendons lying behind the malleoli and extending on the inner and outer side of the foot into the sole. There was extreme distortion and displacement of the toes, the four outer toes being hyper-extended and clawed. Both feet were exactly alike. The diagnosis could be made only at operation. The masses were stripped from the tendons; bone operations and tenotomies were done to correct the deformities. There was no recurrence of the lipomatous masses. The second case was less marked.—*Edward S. Hatch, M.D., New Orleans, La.*

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## ARTHRITIC CONDITIONS

ETIOLOGY AND TREATMENT OF RHEUMATOID ARTHRITIS AND ALLIED DISEASES. S. G. Billington. *Brit. Med. Jour.*, June 21, 1924, p. 1087.

The article deals only with the non-specific bacterial group of cases. These may be classed as:—

1. Rheumatic arthritis, usually polyarticular and associated with pyrexia, and generally controlled by salicylates.
2. The rheumatoid group, polyarticular or monarticular, acute, subacute, or chronic.

A high percentage may be regarded as metastatic manifestations of focal bacterial absorption. Usually the disease represents a definite sequence of events and the treatment required is composite.

Three stages are recognized.

1. Early, with slight or recently developed joint changes.
2. Active arthritis, with definite arthritic changes.
3. Old standing cases with deformities, contractures, and wasting.

In stage 1, removal of the infective focus is usually all that is necessary. In stage 2, the toxaemia must be neutralized in the affected tissues after removal of the infective focus. In stage 3, the treatment is more complex and must include:

(*a*) Removal of the infective focus, if present.
(*b*) Treatment of active arthritis, if present.
(*c*) Electricity, massage, manipulation, exercises or operation.
(*d*) Vaccine as a prophylactic.
(*e*) General and psychological attention.

The differential diagnosis is next considered. Care must be taken to distinguish between active arthritis and post-arthritic sequelae.

TREATMENT:

The commonest focus is dental, but the tonsil, the accessory nasal sinuses, the gall bladder, the genito-urinary system, uterus, prostate, or the appendix may be incriminated. For neutralization of the toxins many drugs have been used. Peptones and other foreign proteins are sometimes useful. Autogenous vaccines are the best. Radiant heat, diathermy and the static brush effleuve are useful. Diathermy and the galvanic

current brought about the removal of effusion. Operative measures include wrenching under an anesthetic, removal of osteophytic growths or hypertrophied synovial membrane, or excision of the joint. The pyschological aspect in the third stage of the disease is very difficult to treat. Unless patients are persuaded that nothing but their own efforts will get them out of bed, they never will get out. The author has found pluriglandular preparations most useful adjuncts in treatment. He believes that the future will demonstrate that the essential chemical basis of the disease is a derangement of calcium metabolism.—*Alexander Gibson, Ch.B., Winnipeg, Canada.*

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THE SECOND GREAT TYPE OF CHRONIC ARTHRITIS IN ITS RELATION TO INDUSTRIAL ACCIDENT CASES. Leonard W. Ely, M.D. *California and Western Medicine*, June, 1924, p. 260.

The problem considered is the relation of trauma to the bone and cartilage change seen in radiograms of so-called hypertrophic or osteo-arthritis.

The view that the bone changes are the results of trauma is challenged because (1) bone can be injured in only one way—*viz*: by fracture; (2) the bony changes seen in these joints take a long time for their production, and when present in radiograms, must have been present for a considerable time previous; moreover, they are usually present in other joints not involved in the injury; (3) these changes are not present in children, yet children are subject to trauma.

The cause of hypertrophic arthritis has long been in doubt. Bacterial infection as a causative agent has not been demonstrated. The author states that intestinal parasites have been found in the stools of a large proportion of patients suffering from this disease, and are suspected as the cause of the bone lesions, their portal of entry being assumed to be suppurative osteomyelitis at the roots of teeth. He has demonstrated foci of aseptic necrosis in the bone marrow near the joints showing these lesions, which foci are the primary changes in production of the lesions. Following the development of these foci come new bone formation at joint margins with spurring and lipping; fibrillation, degeneration, and wearing away of the articular cartilage, with eburnation of the underlying bone. The synovial membrane is traumatized by the altered joint surfaces and becomes thickened, fibrous, and villous.

When a man with such a joint receives an injury, the pain and disability following injury may last indefinitely. He then makes claim for permanent disability. What relation does the trauma bear to the permanent disability? The author feels that the results of the trauma are temporary, and that the permanent pain and dysfunction are caused by the joint changes which existed prior to injury.—*Edward N. Reed, M.D., Los Angeles, Calif.*

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THE USE OF SULPHUR IN THE TREATMENT OF ARTHRITIS DEFORMANS. Hobart A. Reimann, and George W. Pucher. *Am. J. Med. Sc.*, July, 1924, p. 77.

Flowers of Sulphur, dissolved in olive oil and sterilized at 150 degrees for 2 hours, was used; intramuscular injection of 1 cc. (7 mg.), repeated at five to seven day intervals, increasing by 1 cc. each time until seven or eight doses were given. Some cases showed no reaction. Most showed nausea, vomiting, chills, restlessness, joint pains, and head-

ache. Of seventeen cases observed, four showed marked improvement, four slight improvement. No improvement was shown roentgenographically. Three cases are reported in detail, and a table showing results in the seventeen cases. Metabolism studies were also made. Good results were shown only in cases without bony obstruction to joint motion. The results obtained are similar to those obtained by injection of nonspecific proteins. It is doubtful if sulphur has any specific action in arthritis deformans. —*Fred G. Hodgson, M.D., Atlanta, Ga.*

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RHEUMATOID ARTHRITIS, WITH REMARKS ON THE USE OF COLEY'S TOXIN IN THE TREATMENT OF THIS CONDITION. Robert Torrey and Thomas Klein. *Am. Journ. Med. Sciences*, Feb., 1924, p. 275.

Torrey and Klein attempt to carefully differentiate rheumatoid arthritis, atrophic type, from the general group of arthritis deformans, and in particular from osteoarthritis, hypertrophic in character.

They favor the use of Coley's toxin, prepared from cultures of a virulent streptococcus originally derived from cases of erysipelas, combined with B. prodigiosus, as a preparation that is constant in its action and toxicity and relatively stable. It is used intramuscularly, starting with a dose of one-quarter of a minim every two to five days, and doubling the dose until reaction occurs. As the dose is increased to seven or eight minims, the point of extreme tolerance is likely to be reached, and no larger dose is efficient. They state that this method has been very successful in combating the acute inflammatory reaction in the joints. Contractures should be corrected and the usual physiotherapeutic adjuvants used. Foci of infection should receive proper attention. —*C. A. Parker, M.D., Chicago, Ill.*

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## NERVE LESIONS

THE REMOTE RESULTS OF OPERATIONS FOR INJURIES OF THE PERIPHERAL NERVES. Harry Platt and W. Rowley Bristow. *Brit. Journ. of Surg.*, Jan., 1924, p. 535.

In a foot-note the following statement regarding this article appears: This paper represents the British Report on this subject presented at the meeting of the International Association of Surgery in London on July 19, 1923.

The gist of this very pretentious report is well given in the following "Summary":

"1. The results of end-to-end suture.

The results of end-to-end suture in the case of gunshot lesions are for the most part imperfect, both from a neurological and economic standpoint. In an average large series of consecutive operations, complete failures will be found in about 20 per cent.

*a.* The musculospiral nerve heads the list of recoveries, and may be expected to show practically complete restoration of function in at least 50 per cent. of the successful cases.

*b.* The ulnar and median nerves give disappointing results on the whole. In the former, complete recovery in the intrinsic muscles of the hand is so rare as to be almost unknown; in the cases showing recovery, neurotization of the hypothenar muscles alone is fairly constant. The economic results, however, in this nerve are often good, except in individuals whose occupation demands the finer co-ordinated movements of the fingers.

In the median the sensory recovery is always inadequate, and this factor is the cause of the great depreciation in the function of the hand. In sutures of the median in the forearm, complete failure of recovery in the thenar muscles is frequently seen.

*c*. The results of sciatic nerve sutures are poor, and a considerable number of such limbs come ultimately to amputation.

2. The outstanding causes of failure or imperfections—apart from delay, or gross errors in operative technique—are (*a*) Changes in the nerve above the line of suture—either interstitial fibrosis or an ascending neuritis—due in either case to wound infections; (*b*) Topographical confusion in regeneration.

3. The operations of indirect nerve repair (with the possible exception of nerve grafting) have proved ineffective, and should be eliminated from the repertoire of peripheral nerve surgery. Investigations of the results of a small number of nerve-grafting operations in this country suggest that these procedures are of limited value.

4. In the nerve lesions associated with profound irritation (causalgia), resection and suture, or the intraneural injection of 70 per cent alcohol, will rarely fail to bring about immediate and complete relief of the pain, but at the cost of the signs and symptoms associated with complete division of that nerve.

In conclusion, we would wish to make it clear that although a fair and critical survey of the nerve injuries of the war must leave us pessimistically inclined, yet there is a brighter side to the picture. War injuries are complicated by sepsis; but the prognosis for the nerve injuries of civil life must be vastly better, and the experience gained in nerve surgery on the scale which has been possible will help to crystallize our ideas for the benefit of the patient, and for an improvement in surgical teaching."

Of considerable interest is also the "Summary of the Discussion" which was entered into by representatives of several countries, including the United States.

It will be seen that, with a few exceptions, the conclusions formulated by the American and Continental surgeons differ very little from those of the British surgeons, which are embodied in the preceding report of the writers. The experience of the American surgeons, indeed, as presented by Frazier, forms an exact parallel to our own. The reporters were unanimous on certain points, such as the need for the segregation of these patients under the care of surgeons experienced in this branch of surgery, and under conditions where prolonged and careful postoperative treatment can be carried out. In this connection those British surgeons who took part on a large scale in the peripheral nerve surgery of the war period are not unmindful of the great debt they owe to Sir Robert Jones for the organization he created, and for his personal leadership.

The advantages of early operation were emphasized by all, and there was general agreement that resection and end-to-end suture was the operation of choice in every case of nerve injury where the nerve was divided or badly damaged.

If direct end-to-end suture was not possible, the American and British surgeons supported the two-stage operation, while the Continental surgeons utilized one or other of the various methods of grafting to bridge the gap. They preferred, if possible, the autogenous graft, but placed more reliance on the results of this method than we believe is warranted by the statistics quoted.

Certain familiar points in technique were raised during the discussions, *e.g.*, the wrapping of fat or fascia around the suture line; but on the whole the opinion was definitely against the retention of this procedure. It was generally felt that if the nerve bed was not satisfactory, transposition into a new intra-muscular bed was all that was needed.

A stimulating atmosphere was introduced into the discussion by the vivid contribution of Leriche, in which he strongly urged the more general adoption of his operation of peri-arterial sympathectomy. He insisted on its value in dealing with causalgia, trophic changes, and in fact in all cases with signs of nerve irritation. The operation has not been extensively practised in this country, and, as far as we can judge from the few results known, it has not been highly successful. Whether or not it will take the prominent place in this branch of surgery that Leriche and his followers believe it should occupy, time alone can show. The inherent objection to the rationale of the operation at the present time is its lack of sound anatomical basis. For while much remains to be worked out concerning the distribution of the sympathetic fibres in the limbs, it is quite certain that the mass of these fibres do not form a continuous chain localized to the sheath of the main artery over the whole of its course.

On the whole, it was felt that the results of nerve suture in the case of war wounds were disappointing. In many instances, however, it has been encouraging to find that they tended to improve after long intervals. Infection was the outstanding factor in the production of failures, and for this reason the prognosis in the nerve injuries occurring in civil life must always be markedly better.—*C. A. Parker, M.D., Chicago, Ill.*

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THE PATTERN OF WEAKNESS OF THE HAND IN ULNAR AND MEDIAN NERVE LESIONS. Lewis J. Pollock. *Surg., Gyn. and Obstet.*, March, 1924, p. 323.

Eighty-six cases of ulnar and median nerve disturbances are reported. The cases are divided in groups and each group studied, and the strength of a movement is ascertained by spring scales. Physiologic interruption cannot be differentiated from anatomic section by the strength of movement of the phalanges of the fingers in ulnar or median lesions.—*Edward S. Hatch, M.D., New Orleans, La.*

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## CHARCOT'S DISEASE

CHARCOT'S DISEASE OF THE INTERPHALANGEAL JOINT. S. A. Grant. *Brit. Med. Jour.*, June 7, 1924, p. 1002.

A male, aged 55, complained of swelling of ring finger of right hand of three months duration. Onset was sudden, condition was painless, and limited to the proximal interphalangeal joint. There was no previous illness of note. Venereal disease was denied. The joint measured 3¾ in. in circumference and contained fluid. Grating was present; movement was painless. No other joints were affected. Examination of central nervous system showed no abnormality, except loss of sharpness of response to pin-prick over the tip of the nose, and a small area over the sacrum. The pupils were equal, but reacted rather slowly to light. X-Ray examination showed disintegration and pathologic dislocation of the joint, with marked bone destruction. Blood Wassermann reaction was double positive. After three injections of novarsenobillon the joint was considerably less swollen and the anaesthesia over the nose and sacrum disappeared.

Roentgenograms of the condition are shown.—*Alexander Gibson, Ch.B., Winnipeg, Canada.*

JUVENILE TABES DORSALIS WITH DESTRUCTION OF HIPS FROM CHARCOT'S DISEASE. W. G. Elmer. *Med. Journ. and Record*, Apr. 2, 1924, p. lxx.

The history starts with a girl who, at the age of fourteen years, while doing some gymnastic work, complained of sudden pain and disability in the right hip, which she interpreted as a dislocation. Later she was able to walk and run with a shortened leg. After some chiropractic treatment she was operated upon by an orthopaedic surgeon, followed by drainage for twenty-two months.

When examined by the author, the right lower limb was two and three-quarter inches shorter than the left, freely movable at the hip or above, where the upper end of the femur lay on the innominate bone.

There was considerable local swelling and the roentgenogram showed complete loss of head and neck and great destruction of the acetabulum. She had received over fifty injections of neosalvarsan. December 2, 1922, she suddenly felt her left hip give way, and a roentgenogram disclosed a fracture of the neck of the left femur, which later followed much the same course of absorption as the first.

There was an absence of patellar reflexes and presence of Argyll-Robertson pupils and Rhomberg symptom.

The spinal fluid showed a strongly positive Wassermann reaction.

The rarity of the case, occurring in a child, increases its interest.—*C. A. Parker, M.D., Chicago, Ill.*

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## MISCELLANEOUS

SURGERY OF THE KNEE JOINT. Willis C. Campbell. *Southern Med. Jour.*, Feb., 1924, p. 82.

One hundred and sixty-seven cases of the knee joint were taken up, classified and the different varieties gone into in some detail as to their pathology, indications for operations, and results. The following conditions are those mentioned.

Displaced semilunar cartilage; hypertrophy of the external semilunar cartilage; recurrent dislocation of the patella; loose bodies in the knee joint; foreign bodies; miscellaneous traumatic conditions; benign tumors; enlarged villi; diffuse proliferation of synoval membrane; ankylosis of the knee joint; tuberculosis of the knee.—*Edward S. Hatch, M.D., New Orleans, La.*

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ANKYLOSIS OF THE ELBOW: ITS PREVENTION AND TREATMENT. Isidore Cohn. *Southern Med. Jour.*, July, 1924, p. 511.

This paper is limited to traumatic cases, leaving out of consideration ankylosis following infections. Four groups of cases are considered, *viz.*:—

1. Fractures in children, with displacement of epiphysis.
2. Supracondyloid fractures, with vicious union or bony ankylosis.
3. Fractures with displacement of free fragment.
4. Fractures of the ulna, particularly in the upper third of the shaft.

Each group is discussed from the standpoint of prevention of disability, and treatment after disability occurs. The author emphasizes the importance of seeing these

cases early and of securing as nearly as possible anatomic reposition. Cases seen late with bad results usually require operative intervention, depending upon the type of injury.

The paper is well illustrated and the author cites numerous cases to illustrate the various types described.—*Fred G. Hodgson, M.D., Atlanta, Ga.*

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THE USE OF BOILED BEEF-BONE INTRAMEDULLARY PEGS IN THE FRACTURES OF LONG BONES; AN EXPERIMENTAL STUDY. Charles Davison and Frederick Christopher. *Surg. Gyn. and Obstetrics*, April, 1924, p. 534.

Dogs were used in these experiments. The results were as follows:

1. The part of the boiled beef-bone peg which remains in aseptic stable contact with the endosteum of its host, surrounded by living bone, becomes solidly embedded in new bone. The peg undergoes gradual absorption, and is replaced by living bone, which later in turn is absorbed.

2. The part of the beef-bone which lies between the fragments, but not protected by endosteum and not covered by living bone, even with aseptic surroundings, undergoes rapid absorption and disintegration and is not replaced by living bone.

3. When one end of the beef-bone peg is not fixed in stable contact with the endosteum, but remains in position, there is absorption of both the peg and the surrounding live bone.

4. The internal callus, when the mechanical fixation holds and is aseptic, is limited by the beef-bone peg, and does not bridge the line of fracture. The external callus is markedly lessened. The permanent or definitive callus is inhibited.

5. This series of experiments did not produce a single successful anatomic and functional result. *Edward S. Hatch, M.D., New Orleans, La.*

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A CASE OF LEONTIASIS OSSEA. de Massary and Rachet. *Presse Médicale*, June 18, 1924, p. 1031.

The first description of this deformity was by Malpighi in 1697. Ribell published a clinical observation in 1778. Virchow gave it its present name in 1877.

The author's patient was a woman of 63. The superior maxillary bones were hypertrophied enormously, over-shadowing the nasal bones. The hard palate was convex, bulging into the mouth. The lower jaw not being affected, the teeth were thrown out of line of occlusion. The cranium was enormous and irregular, giving to the head the characteristic appearance. Roentgenograms showed marked opacity of the entire skull.

The long bones and other parts of the skeletal system were normal.—*William Arthur Clark, M.D., Pasadena, Calif.*

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ON LATE RICKETS AND OSTEOMALACIA. H. S. Hutchison and Grace Stapleton. *The British Journal of Children's Diseases*, January–March and April–June, 1924.

While osteomalacia is frequent in India, rickets was thought to be rare. The authors find rickets frequent and believe it to be more closely connected with environment than with diet. Many cases referred to them as osteomalacia were found, on

radiographic examination, to be late rickets. The accepted classification makes rickets a disease characterized by incomplete calcification of bone: early rickets, during the first four years of life; and late rickets, from the fourth year to the time of completion of growth, and osteomalacia, a decalcification of bones, occurring after cessation of growth. Osteomalacia is usually considered to be associated with pregnancy, but may occur independently of pregnancy, and even in men. Study of environment in regard to "caste," showed that the higher castes have a great preponderance of the cases of both late rickets and of osteomalacia. Now these higher castes practice the seclusion of their women, and it was found that almost ninety per cent. of both late rickets and osteomalacia occurred among women who were secluded.

The authors found no rickets or osteomalacia among men in India. Investigation of diet disclosed (1) greater caloric and carbohydrate intake among the poorer classes, and (2) greater intake of fats, particularly animal, among the well-to-do. Still, over half the cases, both of late rickets and of osteomalacia, occurred among the well-to-do. Symptomatology:

The onset is usually insidious, with pain and difficulty in walking, but may be with low fever. Pain is referred to the bones of the lower extremities, lumbar spine, and pelvis. Pain is progressive, in both late rickets and osteomalacia, usually with marked remission, in the latter, at termination of pregnancy, to recur with a succeeding pregnancy. Pain in the ribs, and carpal and pedal spasms, is frequent. The gait in osteomalacia is typically waddling and cautious. Curvatures of bones frequently develop, and a marked lordosis is characteristic.

Motor symptoms include diminution of muscular power, which simulates that of pseudo-hypertrophic muscular paralysis, and which is thought to be a myasthenia. When off the feet, the lower extremities are usually held in flexion.

In osteomalacia the patient dreads the least touch or movement, because of the pain produced.

In twenty per cent. of late rickets and in thirty-three per cent. of osteomalacia tetany occurred.

Of the bony changes, curvature of the long bones is more often present in late rickets, the percentage being larger in both conditions the younger the patient. Genu valgum and varum were the commonest changes, but curvature of the long bones, eversion of the ribs, and lordosis are frequent. Incomplete fractures are common. Epiphyseal enlargement and beading of the ribs were often present in the younger patients. The most common bony deformity was found in the pelvis. This consisted in flattening, due to forcing downward of the sacrum, and was much more extensive in osteomalacia than in late rickets. Later, beaking of the pubes and a variety of pelvic deformities may occur. The same symptomatology may occur with or without pregnancy, and the picture may be the same in late rickets without pregnancy.

The radiographic findings included, in the younger cases, marked curvature of the long bones, with multiple fractures; thinning of the cortex to a mere shell, and entire absence in the lower quarter with extension of the cancellous tissue and marked decalcification. The lower ends of the bones splay out laterally and the epiphyseal line is widened.

In the older cases, after puberty, the changes are the same in kind, but less extensive. There is no essential difference in the radiographic findings between late rickets and osteomalacia.

The authors conclude that the same changes occur in late rickets and in

osteomalacia and that the advent of pregnancy produces no essential difference. Since osteomalacia may occur in men, they cannot consider pregnancy a necessary etiologic factor and look upon it as contributory only. They do not consider osteomalacia as a separate clinical entity.

The authors feel that the conditions described as early rickets, late rickets, and osteomalacia are identical and represent the single condition of rickets seen at different ages. Clinically, it is impossible to draw a dividing line between them, all having findings in common, and one picture merging into the other as age advances. Histologically, the identity of the three conditions is held by most authorities. The results of metabolic studies to determine the calcium retention in the three states are too variable to form the basis of any opinion. Radiologically the findings are too similar to justify the separation into three disease entities.

Etiologically, they believe environment has much more causative influence than diet; the particular exciting factors seeming to be lack of sunlight and lack of muscular exercise. In India, late rickets and osteomalacia are found only among females and practically only among those who practice seclusion. The diet and habits of the sexes do not differ except in regard to the seclusion and lack of muscular exercise of the women. Late rickets and osteomalacia appear soon after the practice of seclusion begins. They are found just as frequently in the wealthier classes, who have a better dietary, as among the poorer, and are not found at all among the very poor, who eat no meat, animal fats, eggs or milk.

"A poor diet, *per se*, cannot produce late rickets or osteomalacia: a better dietary cannot prevent them if the environment is faulty."

Pregnancy is an important predisposing cause of osteomalacia. Pregnancy, *per se*, cannot cause the disease, nor can pregnancy plus poor diet. These factors are adjuvants to seclusion in the production of the disease. The amount of calcium withdrawn from the maternal blood to supply the growing foetus is considered far too small a percentage to be considered as a possible cause. Early marriage and lactation are also considered as possible causes, and are ruled out for sufficient reasons.—*E. N. Reed, M.D., Los Angeles, Calif.*

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A Writing Machine for Persons with Amputated Hands. Liautard. *Presse Medicale*, May 17, 1924, p. 841.

This apparatus is designed for patients who are unable to hold a pencil, because of amputation or other disability. It consists of a smooth plate, holding the paper, and a pencil held above it on a bracket. The paper is moved under the stationary pencil and is held against it by four springs fastened to the bottom of the flat box, which furnishes the frame work for the entire apparatus. To make the space between words and lines the paper is separated from the pencil point by pressure downward. In short, instead of the pencil being moved over the paper, the paper is moved under the pencil. Illustrations accompany the description.—*William Arthur Clark, M.D., Pasadena, Calif.*

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A Device for the Relief of Writer's Cramp. Reginald Sayre, M.D. *Jour. A.M.A.*, May 24, 1924, p. 1691.

The object to be attained is a splint that will fix the hand and fingers while writing, and prevent their motion. This is accomplished by making a mould, placing a wet

plaster-of-Paris bandage in the hand, so that it conforms to the shape of the hand while in the writing position. Before this hardens, a pencil is thrust through it, likewise in a writing position. From this a splint is moulded of willow wood, hollowed for lightness' sake. A hole corresponds to the point where the pencil was thrust through the plaster mould. Through this hole, a pen or pencil is then thrust, being retained in position by rubber bands wound around the pencil at the points of entrance and exit.

The writer has found it to be effective, in that, when using the splint, writing is carried on by means of shoulder and arm motions. One wonders if such a splint would not be useful in teaching children to write.—*Edward Harlan Wilson, M.D., Columbus, O.*

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Operative Treatment of Genu Recurvatum. Stracker. *Ztschr. f. orth. Chir.*, 1923, XLIV., 1-2, p. 80.

The anatomic resistance against hyperextension of the knee is found not in the bony structures but in the ligamentous apparatus. The mesial lateral ligament, posterior wall of the capsule, and the anterior crucial ligament are the barriers against hyperextension. But without the protection of the muscles the ligaments are not able to stand permanent stretching. Around the knee such protecting muscles are the semimembranosus, popliteus, and the flexors. In well formed genu recurvatum bone changes are frequently absent, but the ligaments are markedly overstretched. Operative procedures should therefore be directed to the soft structures. Stretched ligaments should be shortened and guarded against future over-stretching by the attachment of protecting muscles. The ligamentum cruciatum lends itself best for this implantation of one of these muscles, either a leg flexor or the tendon of the adductor. Four cases of poliomyelitic genu recurvatum successfully operated upon by this method are mentioned. —*A. Gottlieb, M.D., Los Angeles, Calif.*

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Paracotyloid Bone Centers and Free Bodies in the Hip. Senzio Vacchelli. *Chir. degli. Org. d. Movim.* Oct., 1923, p. 528.

The radiologic observation of bone centers of more or less irregular form situated at the superior border of the acetabulum is not new. Grashey, who was the first to observe these formations, interprets them as supernumerary ossification centers of the acetabulum. Of the same opinion was Stieda, who published two cases of coxa valga in which a small paracotyloid bone nucleus was present. The one to study the details of these formations most thoroughly and exhaustively was Perna. (Chir. degli. Org. d. Movim. Vol. 5, 1922.) He distinguished between os cotyloideum and os acetabuli, the latter being the bone formation found at the junction of the three bones which form the floor of the acetabular cavity.

The x-ray shadows which were observed by the author were situated at the upper border of the acetabulum.

In contrast with some who interpret the presence of this paracotyloid bone as entirely physiologic, there are others who ascribe to it a definite pathologic meaning.

Brand observed two cases of coxa valga with paracotyloid shadows and believed that these were due to bone fragments coming from the cotyloid margin. The examination of 672 roentgenograms of pathologic conditions by the author revealed the presence of paracotyloid shadows in 34 cases, while the observation of 430 roentgenograms in normal individuals was entirely negative.

These roentgenograms were examined in the Istituto Rizzoli and subjected to very close study. Only those cases were considered in which the bony nucleus was a formation in itself entirely distinct from the acetabulum.

Among 500 roentgenograms belonging to individuals afflicted with various pathologic conditions, in five the os acetabuli as described by Ruhle could be observed. Among these five, three were suffering from an arthritis deformans of the hip.

The next hundred roentgenograms which were examined showed the presence of one or two paracotyloid shadows in seven cases. In discussing the nature of these free bony nuclei, or free bones, the author is inclined to attribute their presence to mechanical conditions. In fact, these new formations in seven cases were all observed in patients in whom a reduction of the hip for congenital dislocation had been performed previously, and which were followed by a relaxation, or in which the re-position of the femoral head had not been possible.

In conclusion, the author asserts that the paracotyloid shadow in the roentgenogram, by some called os acetabuli, is not to be mistaken for the os cotyloideum of the anatomist. The paracotyloid shadow may also be observed in apparently normal individuals and is then due to the presence of a sesamoid bone in the long head of the quadriceps.

The shadow is not the expression of one single morbid entity, but may arise from different pathologic conditions. As the polymorphism of this so-called radiographic os acetabuli attests the possibility of various pathogenetic causes, so also it makes it possible for the careful observer to derive conclusions as to its true etiologic meaning from its morphological character.

A large number of the observations were associated with grave deformation of the head of the femur, most frequently following reduction or attempted reduction for congenital dislocation of the hip.—*A. Steindler, M.D., Iowa City, Ia.*

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Pathologic Separation of Upper Femoral Epiphysis in Girls at Puberty. H. Vulliet. *Presse Médicale.* June 21, 1924, p. 537.

Without pathologic change, separation of the epiphysis at the femoral neck is extremely rare in the adolescent. With pathology present, however, the lesion may result from very slight trauma. Five cases are reported in this paper, all girls 10 to 15 years of age, usually over-weight.

Case 1. Girl of 12; 50 kilos in weight; fat and poorly proportioned, but otherwise healthy. Slight limp and pain in right hip on extreme movements. Roentgenogram negative. No relief after three weeks in bed. Some weeks later the hip became totally disabled, following an insignificant fall, and roentgenogram showed separation of the femoral head at the epiphyseal line. Treated by extreme abduction, extension, and slight internal rotation. Observation four years later showed perfect function, but roentgenogram revealed a short thick neck and somewhat flattened head, with good consolidation.

Case 2. Girl of 12. General health good. Intermittent limp in right leg for a year. Examination negative. During a period of limping, fell on left side and was unable to get up, the right leg lying in extreme external rotation. Roentgenogram showed separation of upper femoral epiphysis. Reduction under anesthetic, cast in abduction. Result: short thick neck; somewhat decalcified head.

Case 3. Another same age, suffered complete disability in hip following a slight fall. Treatment same as above. Result: function perfect, slight coxa vara, and decalcification.

It is of interest that in these three cases there was no change in form of the upper end of the femur until after the fall.

Case 4. Girl of 14. 64.2 kilos in weight. Slight pain and limp in left hip for a year. Passive motion limited. Pirquet and Wassermann negative. Clinical diagnosis: coxa vara. Roentgenogram showed separation of epiphysis with almost vertical epiphyseal line, rough, dentate, and somewhat decalcified. Treated by extension for six months. One year later, symptoms had disappeared. There was remarkable reconstruction of the epiphysis, all irregularities gone, but moderate coxa vara persisting.

Case 5. Girl of 12. Pain and intermittent clandication in right leg. Symptoms increased by slight fall, but on rest in bed almost normal function was regained. Roentgenogram showed decalcification in the epiphyseal region; neck in slight anteversion. This is a quite typical case, with intermittent symptoms and mild findings.

Some of the cases, as the result of accident, are brought to notice with obvious lesion and deformities, but many probably are never recognized as pathologic. Sometimes the consolidation is so perfect after trauma that one might think the accident was a good thing for the hip, in that it acted as a stimulant. Perfect function may obtain in a hip, even though there may be a marked anatomic deformity.—*William Arthur Clark, M.D., Pasadena, Calif.*

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Internal Derangement of the Knee Joint.—J. C. Wallace. *Atlantic Med. Jour.*, July, 1923.

The subject of this paper is to call attention to the observations made in the examination of weak knees and to the pathology found in operating on cases of recurrent locking of the knee joint. Dislocation or fracture of the internal semilunar cartilage is the most common cause of derangement of the knee joint. The mechanism of injury and the type of internal derangement are discussed. The author points out four distinct groups of cases that have come under his observation: 1. Typical case of recurrent dislocation of the internal semilunar cartilage. 2. Atypical recurrent dislocation of the joint. 3. Nipping of a tab of fat, which simulated dislocation of the external semilunar cartilage. 4. Recurrent dislocation in which symptoms were not always present.

Dr. Wallace gives the following conclusions. Many patients have knee joints which have accommodated themselves to weakness and are in a position of slight locking all the time, as evidenced by a lack of complete extension. Proper splinting and rest until healing takes place is absolutely necessary in all joint injuries. Repeated locking and trauma to a joint are always followed by a pathologic condition. Lack of complete extension of the knee is the most important sign in internal derangement of the knee joint. Careful and repeated examinations are necessary in making a diagnosis ternal derangement of the knee joint.—*Voizt Mooney, M.D., Pittsburgh, Pa.*

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